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A REINFORCED-CONCRETE BUILDING WITH CONCRETE DOMES: CINCINNATI ZOOLOGICAL GARDEN.

An interesting example of the use of reinforced concrete for structures of a light and ornamental character is afforded by the new Herbivora Building in the Zoological Garden at Cincinnati, O. A general view is shown in Fig. 1, while Fig. 2 is a cross section. The building is rectangular, about 77 × 155 ft. in plan, with a lofty central bay 24 ft. wide, and two side bays 26 ft. 5 ins. wide. The central bay forms the corridor for the public, while in the side bays are the compartments for the animals. The architectural treatment is Moorish in character.

The soil is a firm hard clay, so that only shallow foundations are required, and these consist of flat footings supporting the wall and interior columns. The girders carrying the roof and the upper part of the central bay are reinforced by longitudinal bars at both top and bottom, some of the latter being bent to an incline at the ends so as to pass through the top of the beam at the column intersections, thus providing in part for shear. The main reinforcement for shear in the girders (in addition to the inclined longitudinal bars) consists of transverse stirrups or U-bars. The character of the construction is shown in Fig. 3. The walls and roofs are all of concrete, and a number of special features were involved, including bathing pools in some of the cells or stalls for the sea lion, hippopotamus, etc. The interior columns are octagonal in section, 24 × 24 ins., reinforced with eight ⅞-in. round rods tied together with ¼-in. hoops 12 ins. apart. They have ornamental caps which were cast in place, the whole structure being monolithic. The walls are 6 ins. thick, increased to 10 ins. at the columns, so as to form 4-in. pilasters 3 ft. 4 ins. wide on the outside of the wall; on the inside, the columns project 8 ins. from the face of the wall. The wall column section proper is rectangular, 18 × 18 ins., with four ⅞-in. steel rods, hooped as above described. The columns are spaced 24 ft. c. to c. lengthwise of the building.

The concrete is composed of 1 part Portland cement to 2 parts sand and 4 parts crushed gravel, mixed quite wet so as to thoroughly surround the reinforcing bars. It was handled in wheelbarrows, raised by an elevator in a plank tower at one side of the building. The flat roofs of the side bays are covered with pitch, felt and gravel roofing. The exterior finish consists of a rough or stippled surface below the flat roof, and a smooth troweled surface for the upper part, including the sides and tops of all the domes. The interior is painted. In order to give the required smooth finish to the concrete, dressed lumber was used for the forms.

The principal features of structural interest are the domes, there being a tall central dome of 23 ft. 4 ins. diameter, and four flat domes over panels 24 ft. square. The total height of the former is 67 ft. above the floor line, while that of the latter is 39 ft. It was decided to adopt reinforced concrete for these, thus making the building monolithic throughout. The loading for which the domes were designed (including snow) was 100 lbs. per sq. ft., with 30 lbs. per sq. ft. for wind pressure on the central dome.

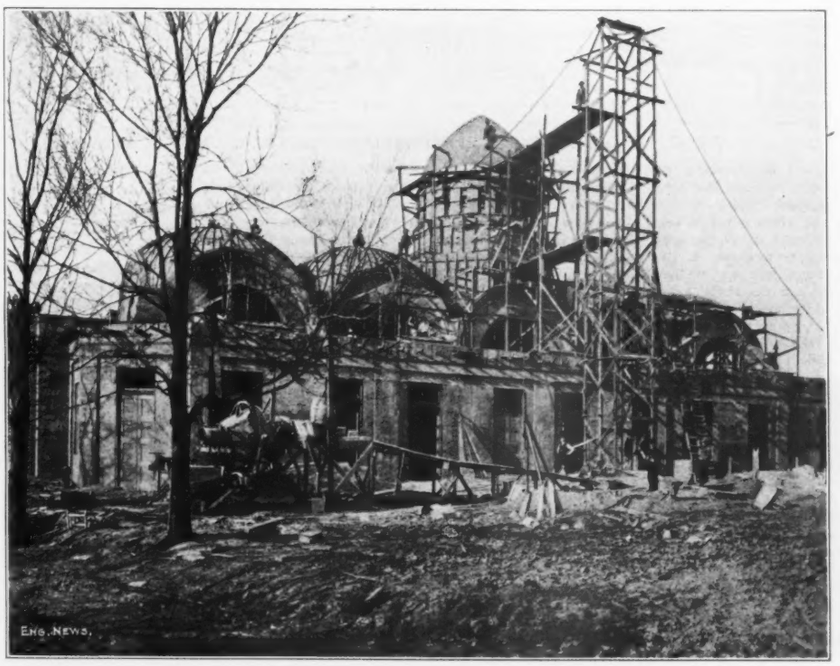

FIG. 1. HERBIVORA BUILDING FOR THE CINCINNATI ZOOLOGICAL GARDENS, WITH REINFORCED CONCRETE DOMES.

Elzner & Anderson, Cincinnati, Architects and Engineers; Collier Bridge Co., Indianapolis, Contractors.

For this dome, Fig. 4, the steel framing consists of radiating ribs of 2 × 2 × ¼-in. angles, the lower ends of which are embedded in the walls of the circular tower forming the base of the dome. The ribs are connected near the base by an interior ring of a ⅜-in. steel bar 2 ins. wide; near the top is a similar ring for alternate ribs, the other ribs continuing to a third ring almost at the apex. Around these ribs are laid rings of ½-in. twisted rods; the splices in the rods have 25 ins. lap and are wrapped in five places with two turns of ⅛-in. wire. The location of these splices was indicated on the architect's plans, thus ensuring a proper distribution. To the ribs is secured a lathing of expanded metal, No. 26 gage, tied at 8-in. intervals with No. 16 wires. This was covered on the under side with two coats of hard plaster (with one-third Portland cement) and a sand finish. When this plaster was hard it served as the form, and the concrete was poured upon it. The thickness of concrete in the shell of the dome (from the inside face of the ribs) is 4 ins.

The other domes rise from rectangular girder frames 24 × 24 ft., and have an interior radius of 17 ft., as shown in Fig. 5. The general design of the reinforcement system is somewhat the same as in the the main dome. There is, however, no interior ring at the base, the girders carrying these flat domes being so shaped as to form buttresses to resist the thrust of the ribs, while ½-in. rods are embedded in the girders and dome. At the crown, all the angles are secured to a ¼-in. center plate, 20 ins. square, by ½-in. bolts.

The concrete of these domes was the same as that of other parts of the structure. The outside was originally a 1-in. coat of cement, soap and alum to form a waterproof surface, but in the first wet season following the completion of the work the domes were found to be far from waterproof. After a number of methods for remedying this had been considered, the original 1-in. surface coat was chiseled off, and a 1-in. coating of 1 to 3 cement and sand was applied, mixed with the Medusa waterproofing composition of the Sandusky Portland Cement Co. This was done during the summer of 1906, and the surface of the domes proved thoroughly waterproof during the winter storms.

This building was designed for the Zoological Garden Co. by Elzner & Anderson, architects and engineers, of Cincinnati, O., and was built by the Collier Bridge Co., of Indianapolis, Ind. The cost was approximately $35,000.

TREATING WOOD THAT IS REFRACTORY TO TREATMENT AND ALSO SUBJECT TO DECAY.*

By DAVID ALLERTON.†

This paper refers solely to the creosoting of the Douglas fir, which is a very refractory wood and one that invariably is injured very much by high temperature or long-continued steaming. Experiments in creosoting fir have been in progress at our plant for nearly a year and the object has been to procure the maximum penetration with the specified amount of creosote to the cubic foot (which in piling is 10 lbs., and this is to be injected without injury to the fiber. The penetration is the sole test of creosoting work. A specified number of pounds is to a large extent misleading. For instance, piling being round presents the least surface; square timbers have greater surface, and planks most of all. A pile 12 ins. diameter having a penetration of 1½ ins. of oil will, other things being equal, require less oil than a square timber of same diameter and penetration. The 12-in. timber, if cut in 3-in. planks, will have complete penetration and require much more oil.

Douglas fir varies much in its structural condition of fiber, and in treating a number of pieces there will be a very considerable difference in penetration. In sawed timber much of this difference is due to the mode of sawing. The timber has a hard and soft side; in one a penetration of perhaps an inch is obtained and in the other twice as much. In seasoned fir piling, some pieces of the same charge will show 2 ins. and some 4½ ins. The penetration varies also to some extent in different parts of the same pile. In using the term "seasoned" it is meant that the wood is rid of its excess of moisture content. This period may be only from two to four months. The practice of cutting fir for piling during the fall or winter months, when the bark does not peel, but has to be shaved off, should be avoided, as this shaving is always imperfectly done and the pile, cannot be satisfactorily treated until well into the next summer.

In treating air-seasoned wood, steaming is not only unnecessary, but a positive disadvantage. The wood is injured to a greater or lesser extent by steaming, depending upon the variety, the temperature and the duration of the process. To treat seasoned timber without steaming, the cylinders must contain steam pipes to keep the solution hot and to bring the wood up to the same temperature, and the pressure must be gradual. If this process is followed the impregnation will be as thorough as if the wood were steamed and there will be no subsequent drip. The excessive steaming to which timber is being subjected at many plants is not only unnecessary, but is the principal reason, combined with the erroneous idea that it is proper to use a very weak solution when zinc chloride is used, which has brought a great deal of discredit upon that process. Zinc chloride in concentrated form is a solvent of lignin and when injected into timber that has not been dessicated by steaming in a solution of moderate strength (4 or 5%) it forms a compound with that substance and is no longer deliquescent, and therefore is not liable to leach from the wood. Creosote once introduced into the wood seems to stay permanently under ordinary conditions.

Three different ways of preparing timber for the injection of creosote were proposed and followed out: 1, Steaming the timber with dry steam and afterward applying a vacuum; 2, The same repeated at short intervals; 3, Boiling the timber in creosote. These three processes were thoroughly tried, the same objection being found in all. With green timber, difficulty was found in removing the excess of water, the fiber was injured and it was practically impossible to inject over 7 lbs. of creosote per cu. ft. With seasoned timber, the fiber was injured and the same difficulty was experienced in injecting the oil, the treatment being superficial.

The method adopted in the case of seasoned fir is to place the wood in a sealed retort and to turn the steam into the coils, the creosote being introduced at a temperature of 170° F. Time was allowed for the exterior of the wood to become of equal temperature with the oil (about an hour), the temperature during the process being usually kept at 175° to 180° F. Pressure was then started very gradually, the idea being to allow the injected oil to follow the expanded and heated cells, for if the pressure was suddenly raised the contraction of the outer fiber effectually stopped the absorption, opposing, as it were, a dead wall. By gradually increasing the pressure the oil in the gradually expanding cells was forced still farther in by the increased pressure of the oil behind. We usually got, in this way, a penetration in seasoned fir of 2 to 4½ ins. in piling, the treatment taking 12 to 14 hours.

In treating green fir we followed the "open tank" method. This consisted of two treatments. The preliminary treatment was the same as mentioned for seasoned fir, except that the water in the wood would be expanded and replaced by the heavier creosote, and, rising to the top of the retort, would be drawn off through a standpipe connected with a ¼-in. pipe and valve. After 12 hours' pressure the oil would be drawn off and the wood and retort cooled for 12 hours, when the process would be repeated, another gradual pressure being maintained for 12 hours. We invariably found that we injected the most oil in the first 12 hours, but got our penetration in the second 12 hours. The average penetration was 1 to 2 ins. This process, with inferior results and consuming 36 hours, is not desirable unless necessary. Both processes require the supervision of an expert or skilled help, for if temperature and pressure are not properly regulated the result will not be satisfactory.

The principle involved in this mode of treatment is to have the wood warmed to as near as possible the temperature of the fluid to be injected. It is apparent that the attempt to force a hot solution into cold, refractory wood must result in failure, but by giving the wood time to expand and the heat time to penetrate toward the center of the timber it is found that the fluid is gradually forced in, in proportion as the interior heat increases. It is well known that it is difficult to heat large timbers to the center, wood being such a poor conductor that the process is a slow one.

*Abstract of a paper read at the annual meeting of the United States Wood Preservers' Association, at Kansas City, Mo., Jan. 21-23.

†Superintendent, American Creosoting Co., Marion, Ill.

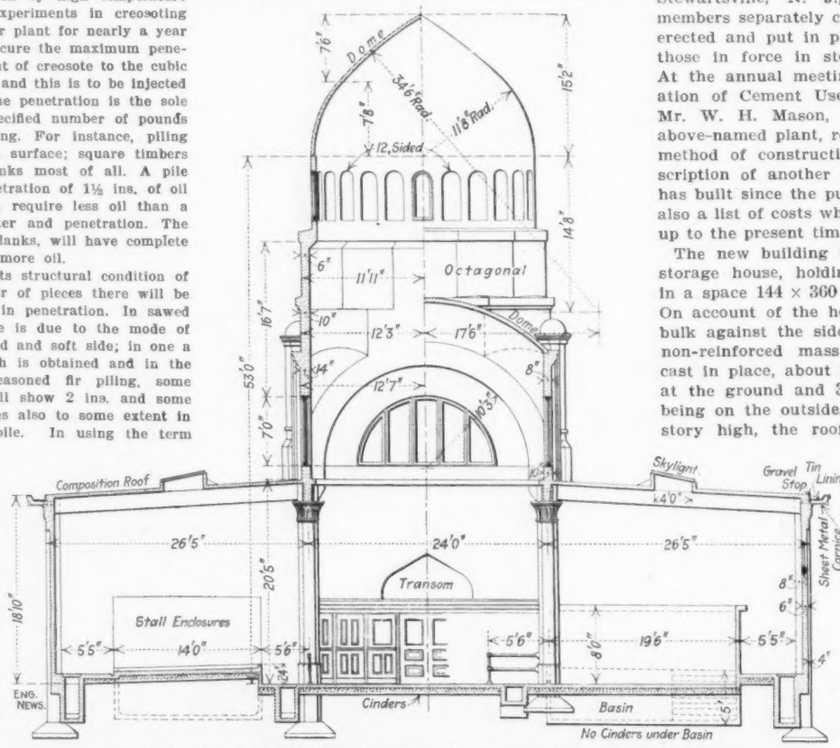

FIG. 2. CROSS-SECTION OF HERBIVORA BUILDING, SHOWING DOMES.

A CEMENT STORAGE HOUSE WITH SEPARATELY MOLDED REINFORCED-CONCRETE MEMBERS.

In our issue of July 4, 1907, p. 5, we described quite fully a building which had been erected at the plant of the Edison Portland Cement Co. at Stewartsville, N. J., with reinforced-concrete members separately cast on adjacent ground and erected and put in place by methods similar to those in force in steel or timber construction. At the annual meeting of the National Association of Cement Users at Buffalo on Jan. 21, Mr. W. H. Mason, the superintendent of the above-named plant, read a paper upon this same method of construction, which contained a description of another building that the company has built since the publication of our article and also a list of costs which have not been available up to the present time.

The new building is to be used as a cement storage house, holding 350,000 bbls. of cement in a space 144 × 360 ft. in plan and 30 ft. high. On account of the heavy pressure of cement in bulk against the side walls they were made as non-reinforced mass concrete retaining walls, cast in place, about 2 ft. thick at the top, 7 ft. at the ground and 30 ft. in height, the batter being on the outside. The building is only one story high, the roof being 12 × 6-ft. × 4-in. slabs carried on girders resting on 32-ft. columns. All of these members were cast in reinforced concrete in a shop about a half mile away from the building, according to the same methods and design described in our previous article.

One minor change should be noted. All members were cast on the same casting floors, using in many cases two finished pieces as molds for one cast between them. So also members were cast on top of those already molded, from which forms had been removed. In the first buildings erected, different kinds of paper, bare, oiled, waxed and soaped, were used as a separating sheet to keep adjoining members from sticking together, but as the paper was hard to remove from the concrete, it could hardly be called a satisfactory solution of the problem. In the later building, one and sometimes two coats of thick whitewash were applied to the surface of a member one day after it had been cast, and this proved a simple and effective means of maintaining a plane of separation. As everything around a cement plant soon assumes a uniform color, the discoloration by the whitewash was of no account in this instance.

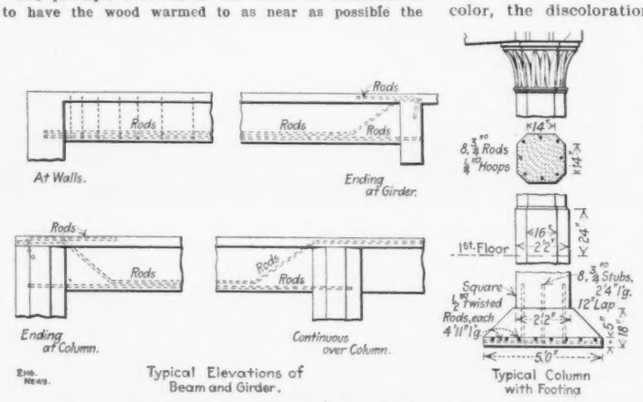

FIG. 3. TYPICAL COLUMN AND GIRDER CONSTRUCTION.

COSTS. — The following is an extract from Mr. Mason's paper showing costs on the storage-house. It should be particularly noted that the Edison Portland Cement Co. had cement and stone in stock and that Mr. Mason has estimated their worth at $1 per bbl. and 60 cts. per cu. yd., respectively. These costs are much cheaper than the usual contractor must figure, and a corresponding increase should be made in the total cost of the concrete. In his original paper Mr. Mason also gives comparative costs of timber construction, but as he merely assumes timber columns and beams of the same size as the concrete members used, the comparison is valueless. To be of any use for comparison the design should have been worked out in timber and the estimates made on the sizes so deter-

mined. It is extremely doubtful if timber would be found economical for this size building under any design, but it is surely folly to estimate the costs of timber columns 32 ft. long out of 18-in. square sticks and girders 24 ft. long and of 12 × 26-in. section. The estimate of costs follows:

We now come to the important part of all engineering structures—the cost. Accurate costs were kept of the cast members which will be given later, but before going into these I want to give you some general data in regard to making the 1,048 pieces necessary for the building.

The work on these cast members was started Sept. 25, 1907, and completed Nov. 23, 1907; that is, it was all done in two months. Of course, some preliminary work had been done previously, such as setting up concrete mixer, laying railroad track, and making a few casting floors to start on. The average number of men employed during this time was 23. Eleven of these were classed as carpenters and foremen, whose average rate was 24 cts. per hour; twelve were classed as laborers, whose average rate was 15 cts. per hour.

The lumber used for making the 1,048 pieces was 7,000 bd. ft., which at $27 per M. makes a total of $189.

The total amount of steel used was 201,400 lbs., the average price of which delivered at our mill was .0203 cts., or a total cost of $4,088.

The mixture used was 1 to 6, using the run of crusher stone straight without sand. The stone would all pass a ¾-in. screen.

In the following costs the stone is figured at 60 cts. per cu. yd., while the cement is figured at $1.00 per bbl.

Cost of Each Column Complete on Casting Floor.

Cost of steel	$7.57
Cost of material for concrete	5.48
Carpenter labor	4.27
Labor, making and placing concrete and reinforcing	1.95
Total per column	$19.27

[The columns are 18 × 18 ins. sq. and 32 ft. long with offsets at the base which bring their contents up to 2.8 cu. yds.—Ed.]

Cost of Each Girder Complete on Casting Floor.

Steel	$5.53
Concrete material	3.51
Carpenter labor	2.26
Labor, mixing and placing, etc.	1.34
Total per girder	$12.64

[The girders are 12 × 26 ins. x 24 ft. with a contents of 1.9 cu. yds.—Ed.]

Cost of Each Roof Slab Complete on Casting Floor.

Steel	$1.69
Concrete material	1.85
Carpenter labor	.423
Labor, mixing and placing concrete, whitewashing, smoothing tops, etc.	.405
Total per slab	$4.37

There are 72 sq. ft. in each slab, therefore the cost per sq. ft. is 0.0607 cts., or $6.07 per 100 sq. ft.

Now let us compare this with corrugated iron as a roofing material. Our usual practice on roofs is to use No. 18 gage corrugated iron:

Weight per square with usual lap is 292 lbs., at $3.05 per 100 lbs. (for the iron alone)..	$8.92
Paint for 3 coats	.61
Labor painting	.36
Labor putting on	2.75
Total per square in place	$12.64

I have not the actual figures for laying the concrete slabs, but we have a bid from a responsible party to erect the entire roof, columns, and girders for $1,932.00. I believe we can do it cheaper by day labor, but let us assume this as the cost and allow the erection of the slabs to be one-half of it, as there are 518 squares in the building:

Cost of erection per square is	$1.86
Cost of slabs per square	6.07
Total cost in place	$7.93
To sum up we have cost of concrete roof slabs in place per square	$7.93
Cost of No. 18 gage corrugated iron in place per square	12.64

That is, the cost of the corrugated iron is more than 50% above the cost of the concrete roof slabs.

We tested one of the roof slabs to destruction: it failed at 7,700 lbs. center load, with 12-ft. span. This gives an ample factor of safety for a roof.

THE USE OF PREPAYMENT STREET CARS in Newark, N. J., is to be preceded by several weeks' demonstration with a car run over the various lines, according to current press reports. It is expected that after a few weeks several cars will be placed in regular service and that, if the people generally accept the prepayment idea as beneficial, similar cars will be placed on all the lines of the Public Service Corporation. The general arrangement of this type of car was shown in Engineering News, Nov. 21, 1907. Many of the cars on the lines about Newark are built with such extended rear platforms that their conversion to the new type would seem simple.

SHEATHING PIERS ON LAKE ERIE WITH DIVERS.

By WILSON T. HOWE.*

The work of divers in submarine construction has not been the subject of much comment in engineering literature, and for that reason it is thought that the following account of a piece of work done under the writer's supervision may be of service to those who have occasion to estimate on similar projects.

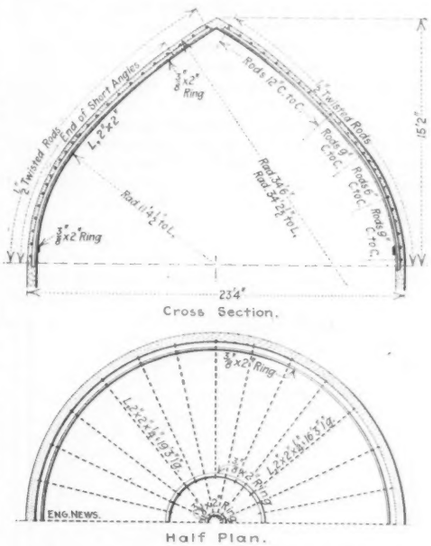

Fig. 4. High Dome of Herbivora Building.

During the last few years, the superstructures of many of the old wooden piers and breakwaters at the harbors on Lake Erie have been rebuilt by tearing down to about three feet below mean lake level, and building up from that point with concrete. Below the concrete it has been the practice to cover the old timber substructures, or cribs, with three-inch hardwood plank, both to strengthen the old work, and also to protect it from wear by sand in suspension and from cutting by ice. It is not attempted to go to the bottom of the cribs, as that would require dredging away from four to ten feet of sand or mud. The plank are put on of such length as to cover only the exposed portion from the bottom of concrete to the sand or mud.

It is specified that the plank shall be good merchantable maple, beech or other hardwood, 10 to 14 ins. wide, square edged, and free from loose knots, shakes or other imperfections. They are fastened with 14 × ¾-in. gimlet-pointed lag screws with 11-in. thread and washers; there are two fastenings at the top of each plank and single fastenings spaced two feet apart below the top. Holes bored for lag screws are full length of the lag screw and 1/16-in. less in diameter. They may be partly driven with a light hammer, leaving at least four inches to be screwed up with a proper wrench.

The work in question was at Huron, O., and consisted of sheathing 343 lin. ft. of old pier on both sides. The planks were in lengths of from 5 to 14 ft., and the tops of planks were about four feet below mean lake level.

The force employed to cut the plank to right lengths, bore, hang and bolt, was two divers, two tenders, two helpers, and one engineer to run air compressor. The boring of holes in plank and pier and the turning in of lag screws was done by compressed air, the air for which was furnished by a 10 × 10-in. compressor to a tank holding 55 cu. ft. under 100 lbs. pressure. From the tank was a 1⅝-in. air line from which the boring machines worked directly. Air for the divers was taken from the main line into a smaller tank holding about 9 cu. ft. Between this tank and the air line was a reducing and regulating valve which kept the pressure for the divers at about 25 lbs.

The planks were cut to right length and laid side by side on top of the pier, near where they were to be placed below, and the holes bored in them for lag screws. Two small extra holes were also bored, one about 2 ft. from the bottom of plank, the other about 1 ft. from the top, into which were driven 60d. wire nails, and left sticking out about three or four inches. A rope with a flat weight on the end was then given one turn about the lower nail, thence one turn around the upper nail. The plank thus weighted and held by a helper was slid over the edge of the pier to the diver below, who placed it in its proper position on the side of the crib, and fastened it by driving in the nails. The helper then pulled up the rope and weight, and sent down the next plank.

For the aid of the diver in fastening the plank, a staging about fifteen feet long was hung about four feet below the tops of planks, and by means of a triangular-shaped bracket was held away from the face of pier about three feet. Standing on the staging he adjusted the plank and drove in the top nail, then dropping down inside the staging fastened the lower end. The tender then pulled him up to the staging again, and he was ready for the next plank. It was thus necessary to move the staging after placing 15 or 18 plank. The diver, his tender, and helper could place about forty planks per day of eight hours, including moving staging, notching out plank for bolt-heads and other delays incidental to under-water work.

On a part of this work the heads of bolts used in fastening together the timbers of the cribs projected, and it was necessary to countersink the plank. Two vertical rows of these bolts occurred every 9 ft., and after fastening on the plank, next to such bolts, the diver would locate their projecting heads from that plank. This was accomplished by means of a gage made of ½-in. gas pipe, 12 ft. long, carrying movable collars, with set screws, each collar holding a ½-in. gas-pipe arm, 12 ins. long, projecting at right angles to the main pipe. Upon each arm is a sleeve movable in or out on the arm and fixed

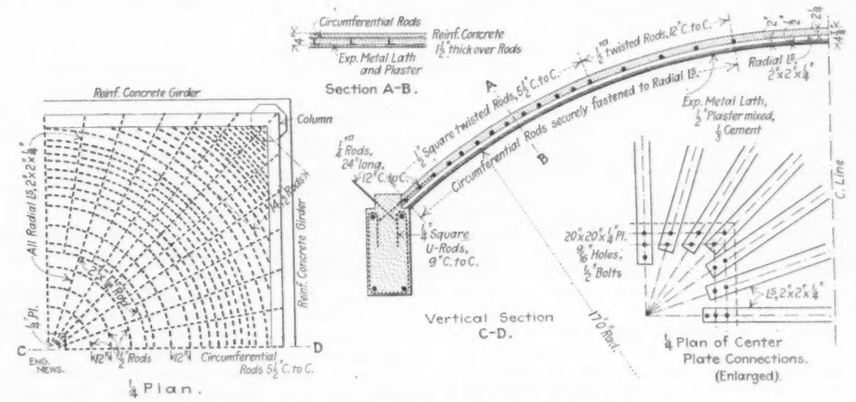

FIG. 5. LOW DOMES OF HERBIVORA BUILDING.

*U. S. Junior Engineer, Huron, O.

in any position by a set screw. The ends of the rod are bent at right angles for two or three inches, and sharpened. In locating the bolt-heads the gage was placed at the edge of the plank last fastened, held by driving in the sharpened ends, and the arms and sleeves were adjusted so that they represented the position of the bolt-heads. The whole apparatus was then laid on the next plank to go on, the position of the sleeves marked on the plank and the proper notches cut. The countersinking was done by boring about half way through the plank with a 3-in. augur.

In boring into the pier and putting in the lag screws, the diver hung his staging as low as he could and yet be able to reach the holes in the top of the plank. He then bored through the holes in the plank into the pier. Occasionally the augur would strike a drift-bolt or other iron in the pier, and in that case another hole near by had to be bored through the plank. After boring all the holes within reach of his staging, the boring machine was pulled up by the helper, who then sent down the number of lag screws signalled for by the diver. These were arranged in bunches of five, with the washers on, a noose in the end of a small line slipped over the heads below the washers and passed down to the diver. After sticking the lag-screws into all the holes bored within reach, the auger in the boring-machine was exchanged for a socket-wrench made to fit the heads of the lag-screws, and passed down to the diver, who turned in all the lag-screws placed. After these were turned in, the boring-machine was pulled up, and the staging lowered to cover the next lot of holes. When the diver finished bolting all within the horizontal reach of his staging, the latter was moved along the pier to cover the next lot of unfastened plank. At each setting of the staging from 25 to 45 lag-screws were placed, depending upon whether the work was at the top of the plank or lower down.

In a day of eight hours, 230 lag-screws have been put in, but an average was from 190 to 210. One diver did all the hanging of plank in place, the other all the boring and bolting.

Exclusive of setting up the engine and boiler, and other preparatory work, the actual work of putting on the plank took 36 working days, of 8 hrs. each, in which time was placed 21,677 ft. B. M. If one diver had done all the work, this reduces to 301 ft. of finished plank per day, a figure which agrees closely with a previous piece of similar work under the writer's supervision.

The following table shows the accurate labor cost for the work.

2	Divers	@ $10.00—36	days.....	$720.00
1	Tender	" 3.50—36	"	126.00
1	Tender	" 3.00—36	"	108.00
1	Helper	" 3.00—8½	"	25.50
1	Helper	" 2.50—28	"	70.00
1	Helper	" 2.00—25	"	50.00
1	Engineer	" 3.00—34½	"	103.50
	Total cost for labor for 21,677 M. ft.....			$1,203.00
	Or $55.50 per M. ft.			

A TRAVELING MOLD FOR MAKING REINFORCED-CONCRETE PIPE.

By F. TEICHMAN,* M. Am. Soc. C. E.

A portion of the Salt River project of the U. S. Reclamation Service consists of a 19-mile canal that carries water for power purposes. The power is developed at the Roosevelt Dam and is used at present in the construction of the dam, and later will be transmitted electrically to the Phoenix Valley to pump there water for irrigation. At two places on the line of the canal it crosses depressions, at both of which the crossing is made on tangents with inverted siphons of reinforced-concrete pipe which were built on the ground by means of a movable form, called an "alligator," designed by the writer.

Mr. C. W. Smith has given in a paper before the American Society of Civil Engineers† a description of these pipes, but did not devote much detailed attention to the design and working conditions of the forms which are described in the present article.

The two crossings are at Cottonwood Canyon, where the length is 250 ft. and the head 76 ft., and at Pinto creek, with length of 2,130 ft. and head of 35 ft. At both places two pipes each 5 ft. 3 ins. in inside diameter, were used; one of the twin Pinto pipes is shown in Fig. 3; the Cottonwood pipe is similar in construction but is 7 ins. thick, reinforced with 10 longitudinal rods and the rings are 3 ins. c. to c.

The forms consisted of an outside detachable steel framework with wooden lagging and of an inside form made of steel.

The inner mold was made up of three functionally different parts: the lower front part of the mold, which was slowly pulled along with the progress of the work and went by the name of "alligator;" the upper stationary plates; and, thirdly, the lower stationary plates. The upper stationary plates were erected over the slowly moving alligator and supported by rails that were part of the moving form. The plates of the alligator formed the lower half of the circle, and the upper stationary plates formed the upper half of the circle of 5 ft. 3 ins. dia. As the upper stationary plates were built up in half cylinders they were bolted to the half cylinder of previously erected plates, so that the upper stationary plates formed a rigid half cylinder of about 70 ft. length. The half cylinder of the alligator had a length of about 24½ ft. and beyond that, towards the front end, the alligator sloped to a point for about 10 ft., incline 1 in 4. The rails of the alligator that supported the upper stationary plates extended a few feet beyond the rear end of the alligator and as it pulled away from under the stationary plates, each individual half cylinder of stationary plates, while it was still supported by the projecting rails (and also by the adjoining stationary plates), was given a support by a pair of lower stationary plates introduced in the space vacated by the alligator.

The transportation of the parts of inner mold from rear end, where they were dismantled, to forward end, where they were re-erected, was accomplished by a car on rails inside the mold, that was pulled along by means of ropes actuated alternately by the erecting plate men at front end and by the dismantling plate man at the rear end of inner mold. All parts, except those of the alligator, were of such weight that one man could handle them without difficulty.

The modus operandi, with the pipe in progress of construction, is now as follows (Fig. 2): The alligator is moved forward with the sloping edge just a little ahead of the working face of the concrete. The upper stationary plates, dismantled at the rear end, as the concrete has set sufficiently, are placed on the car by the rear plate man and pulled forward by the two front plate men and erected by them over the alligator and bolted to the previously erected half cylinder of upper stationary plates. The car returns to the rear plate man, is loaded with the lower stationary plates, just dismantled, pulled forward and these plates are placed on the concrete partly set and just exposed between the rear end of the moving form and the foremost lower stationary plates. The newly placed plates are then made the support of the upper stationary plates which at that moment are still supported by the projecting rails of the alligator but will shortly lose this support as the alligator moves further ahead.

Describing now somewhat more in detail the three parts of the inner mold: The object of the

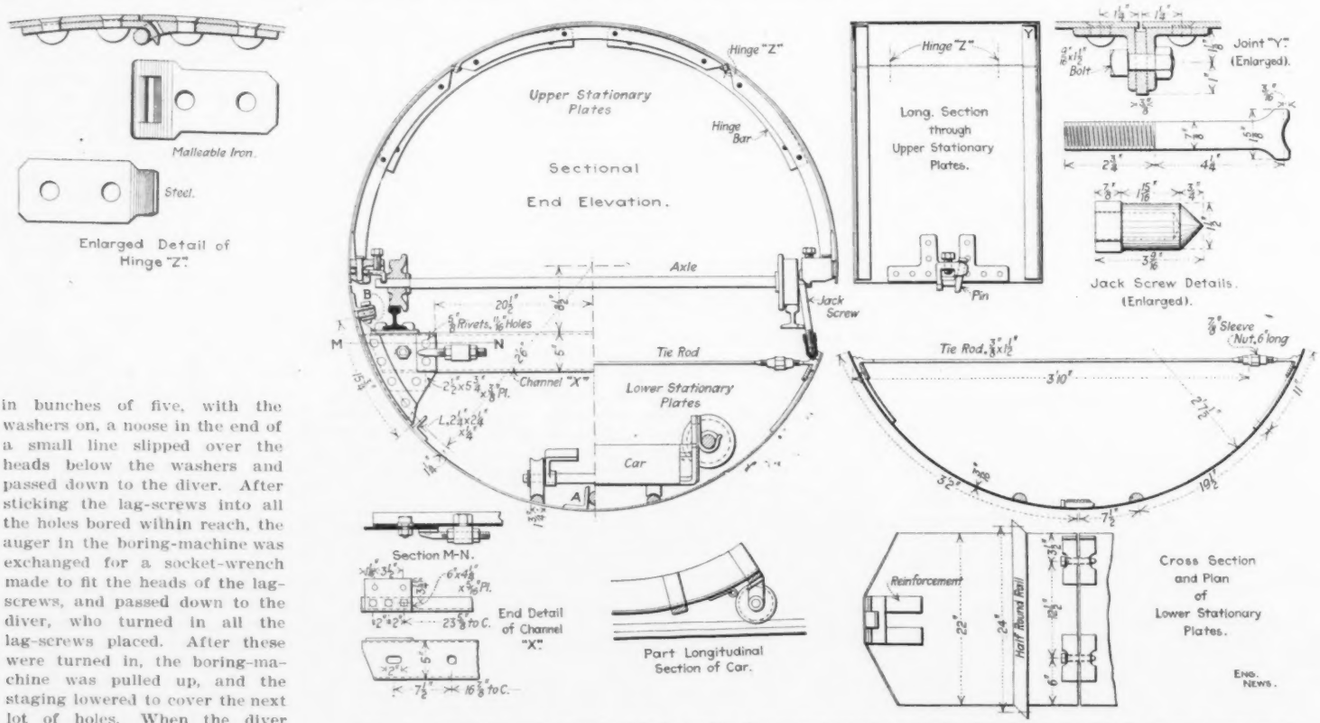

FIG. 1. DETAILS OF INNER MOLD USED ON REINFORCED-CONCRETE PIPE IN SALT RIVER PROJECT.

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†Reinforced-Concrete Pipe for Carrying Water Under Pressure, by C. W. Smith, Assoc. M. Am. Soc. C. E. Paper presented Oct. 2, 1907. Proceedings, Am. Soc. C. E., Aug., 1907, p. 581.

tapering form of the sliding mold is, of course, to have the working face of the concrete always at or near the edge of the taper and thus in full view and fully accessible. The tapering form of sliding mold was patented (1886) by Mr. Ernest L. Ransome, for use in constructing concrete lined ditches and open conduits for cableways, etc. It was Mr. Ransome's sliding mold, with tapering front, that was used (17 years ago) in building the concrete conduit of the Piedmont Cable Railway, Oakland, California, of which the writer was designing and constructing engineer.

The alligator of Arizona has six articulate courses, five half cylindrical courses, each 30 ins. long and the front course of about 12 ft. length, which has a taper of about 10 ft. The courses are held together (Fig. 1) at the bottom of the semi-circle by bolts (A) held against angle irons riveted to the plates, and near the upper edge of courses by two drawbars 1 × 2¼ ins. (B) laid between angle irons and pinned to same. By removing these pins the drawbars can be removed, and by removing also the bolts at the bottom line the alligator is dissected into its six parts, ready for transportation.

Each course of alligator has as a horizontal stay a 5-in. channel to which are bolted the two rails of a track that projects about two feet over both ends of the cylindrical part of the alligator. As shown, the connection of these channels with the cylindrical plates of the form permits an expansion or contraction of the form without affecting the track. At the bottom of the form are shown the two half-rounds which form the track for the car that is used to bring the dismantled plates to the front. The different horizontal angles and half-rounds that are riveted to a course reach slightly over the end of the course and are cut there on a slant so as to permit a like projection to the angles and half-rounds of the next course. These projecting angles and half-rounds hold the different courses in alinement.

The alligator was pulled ahead by means of a ⅞-in. steel rope, about 500 ft. long, to any point of which could be clamped a two-sheave block, the second block being tied to a dead man set about 600 ft. ahead of the mold. The 9-16-in. rope of the blocks was taken

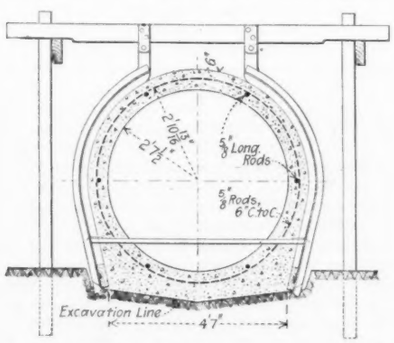

Fig. 3. Cross-Section of Pinto Pressure Pipe.
(From Proceedings Am. Soc. C. E., August, 1907, p. 583.)

sideways to a windlass and this was operated by a horse. For the guidance of the moving form a track of two 2 × 4-in. scantlings was placed in the ground, on a line with the base of the excavation, and an outrigger of the alligator slid thereon.

The upper stationary plates are 24-ins. wide; each course in three parts, hinged as shown. At the hinges the connection of plates is stiffened by circular bars bolted in between courses. The side plates of each course have malleable castings by means of which, and of the wheeled axle, each course rests on the rails of the alligator. The castings have clips, screws and pins. The clips lock into notches of the axles and by means of the screws the clearance between upper edge of alligator plate and lower edge of stationary plate is adjusted. The pins held the axle in position in the castings. With the pins removed the axles can be inserted or removed horizontally.

If for any reason the withdrawal of the alligator should be impossible (the concrete having set firmly around it) it is seen that the inner form can be removed by first removing the axles, then the upper stationary plates, beginning with the side plates (swinging them on the hinges, towards the inside) and then contracting the side plates of the alligator, by operating the nuts in front of the six 5-in. channels of the six courses of the alligator.

The function of the lower stationary plates is to support the upper stationary plates, after the rails of the alligator have ceased to support them. The lower plates are placed on the invert

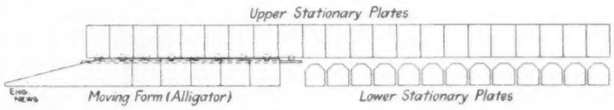

FIG. 2. DIAGRAM SHOWING WORKING PROCEDURE IN MAKING REINFORCED CONCRETE PIPE.

of the pipe when the concrete there is only partially set. The lower plates must therefore have in their lower portion a certain flexibility to accommodate themselves to the concrete surface as they find it, and the upper portion of the plates must be prevented from pressing outwardly with a much larger force than is required for the support of the invert at that place. The plates as shown fulfil these requirements. The plates are made in halves, pinned together at the bottom line; they are 2 ins. shorter than the upper plates but the half-rounds of track that are riveted to the plates are as long as the upper plates. These half-rounds are cut at the ends on a slant so as to center the plates and track more readily when placing them. Near their upper ends the plates are reduced in width and stiffened, and the upper ends of the plates of one pair can be connected by hooking into them an horizontal adjustable tie rod. This rod has near each end a conical depression into which is placed the conical end of the nut of the jackscrew. The upper end of the jackscrew is formed as a crutch and is placed against the axle of the upper plates that are to be supported. The nuts of the jackscrews were turned by hand, and so were the sleeve nuts of the tie rods, and the plate men very soon learned to give the jackscrews and tie rods the proper adjustment to accomplish a support of upper plates equivalent to that given by the rails of the alligator.

The space between the foremost lower stationary plates and the rear end of the alligator must be bridged by a car track that is available while this space increases from a few inches to more than two feet (as a result of the advance of the moving form). This is accomplished by what was called the track bridge, a simple device that was dropped in at the front end of the foremost lower plate and that rested on the rear course of the alligator, sliding thereon as the alligator crawled along.

This describes the inner mold. The outer mold and its support is represented in the accompanying half-tone (Fig. 4), which, however, does not represent the mold at any period of actual pipe construction, but which shows the outer mold removed and the inner mold much in advance of its working position—the taper of the alligator properly being only a few inches ahead of the inclined working face of concrete. A few of the ribs of outer mold are seen suspended from the scaffolding. These ribs are made of flat bars, curved. To these ribs are riveted light angles, the bar projecting at the inside beyond the angles for a distance equal to the thickness of the lagging. The ribs of the outer mold were held equi-distant, at the point of suspension, at their lower ends (by a simple provision at the lowest piece of lagging) and at half-height by spacing rods, dropped over small projections of the ribs. The scaffolding that supported the ribs also supported the wheeling planks.

The pipe machine was originally intended for continuous work, but the slow setting cement furnished at that time by the Government cement mill would have required a much greater length of mold than was built and it was found that there was not much difficulty in starting the alligator in the morning after it had been moved—slightly—late the previous evening. The work was therefore done by eight-hour day labor.

The concrete was hand-mixed: 1 cement, 2½ sand, 4 gravel, requiring screening in part, and found near the place of construction. A wet concrete mixture was used throughout. Joints at the end of day's work—about 40 ft.—were finished in vertical planes, the stopping off being done by sand bags placed between the inner and the outer molds. The cost of labor, including foreman and timekeeper, was about $2.50 per foot of pipe, or about $6.50 per yard of concrete. This includes all work from screening and hauling gravel to pointing and brush-washing inside of pipe and wetting outside, also all work on forms and scaffolds, repairs, bending and placing of reinforcement, but does not include excavating and refilling.

The work done by the pipe machine was on the whole satisfactory. As to amount (40 ft. per 8 hours) it could easily have been doubled if the mold had had a greater length; and for continuous work, using a mold of considerable length and cement of quicker set, 250 ft. per 24 hours could have been accomplished.

A considerable improvement of the apparatus

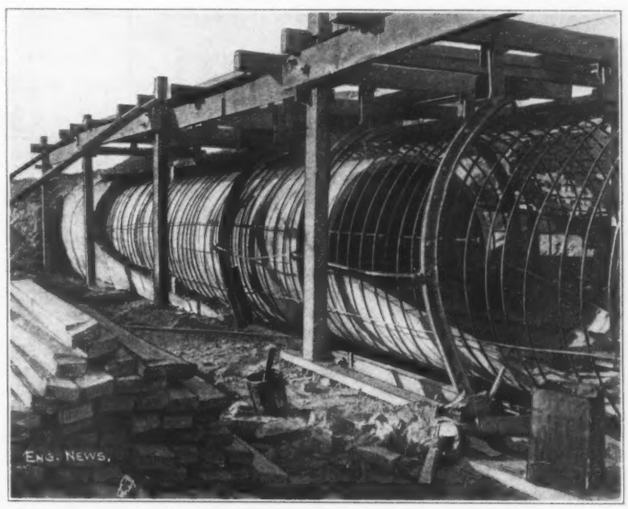

FIG. 4. VIEW SHOWING CONSTRUCTION OF PIPE BY MOVABLE FORM.

would be as follows: Place two wooden sills (4 × 6 ins. or 4 × 8 ins.) on base of excavation, parallel with pipe, about 5 ft. 3 ins. between the 4-in. faces of the two sills. This width, 5 ft. 3 ins., represents the concrete base of the pipe. The two sills serve as a guide for the alligator; they also represent the lowest lagging of the outer mold and they form the sills for the support of the ribs of the outer mold, each pair of ribs being bolted together at the top and the succeeding pairs being kept equidistant by spacing rods. In this manner constant concentricity of inner and outer mold in gained, no special track for the

alligator is required, and the ribs of the outer mold are not supported by the same structure that has to carry the wheelbarrows, a construction that is objectionable if not carefully made because the passing wheelbarrows may occasion vibrations in the outer form and thus disturb the concrete while setting. With improved conditions of concentricity the thickness of the pipe may be reduced one inch or more.

It should be remarked, while the type of mold with moving form is very serviceable for straight pipes of great length, it will be found less desirable where the direction of the pipe is subjected to frequent changes in a vertical or horizontal sense, because such angles would mean interruptions in the continuity of the work. It should further be stated that the moving form, if not made fairly true and if handled carelessly, may be disappointing for the reason that some concrete particles may adhere to the form and these then will make the face of the invert scarred; furthermore, in reinforced pipes the withdrawal of the moving mold, if not fairly true and not well handled, may disturb the concrete while setting and occasion a defective union between reinforcement and concrete. On the other hand, for water pipes with little pressure or for sewers, the mold as described will build these structures quickly and cheaply, even if operated by inexperienced hands, and with a true form of mold, well handled, it is successful also for reinforced pipes.

One feature that all molds should possess, to be successful, is an interior track for the transportation of plates of inner mold.

BENCH LEVEL OPERATIONS ON THE CATSKILL AQUEDUCT LINE.

By M. E. ZIPSER.*

In carrying out its plans for providing an additional water supply for New York City, the Board of Water Supply made extensive surveys and investigations to secure the best location for an aqueduct from the Catskill Mountains to New York City. It was realized at the beginning of the work by the Chief Engineer, Mr. J. Waldo Smith, M. Am. Soc. C. E., that numerous and extensive lines of levels would have to be run in connection with these preliminary surveys, and in what follows the writer has attempted to give the salient features of the bench level work executed under the supervision of the Northern Aqueduct Department. This department has charge of that portion of the Catskill Aqueduct extending from the Ashokan Reservoir to Croton Watershed, approximately sixty miles in length.

In the fall of 1905, after the general route of the aqueduct had been tentatively located, it was decided to run a line of accurate levels along the roads following the general direction of the proposed aqueduct line. The bench marks thus fixed were intended for vertical control in establishing benches along the line of the aqueduct which, it was anticipated, would be available on final location, but which were intended primarily for subsequent construction work. On account of the number of routes investigated and changes made, considerably more leveling was done than originally contemplated, the total distance covered being 585 miles of single line.

To carry on this work two parties were organized, each consisting at the outset of an instrument man and two rodmen. Later there was added to each party a fourth man, who acted as recorder. The writer was in charge of, and directed the operations of, both parties.

The datum plane adopted is that of the U. S. Coast & Geodetic Survey, which is mean sea level at Sandy Hook, N. J., and the levels are based on the elevations of those bench marks of the Coast & Geodetic Survey which are located on the east shore of the Hudson River along the N. Y. C. & H. R. Railroad between Peekskill and Rhinecliff. From such of these primary benches as were convenient for the purpose, levels were carried back into the country and the ends of these spurs were connected by lines of levels run approximately along the line of the aqueduct. All lines were run independently by each party, the second party running in an opposite direction to the first party.

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At the beginning of the work the instrumental equipment of each party consisted of an 18-in. Buff & Buff erecting dumpy level, two New York extension rods provided with special targets and the other accessories. The targets were clamped to the rods in the usual way. They were rectangular in shape, 5 × 6½ ins., painted black with a white enamel strip across the middle, ⅜-in. in width at the ends and ⅛-in. near the vernier. This strip was bisected by the horizontal cross wire, and experience has shown that a more accurate setting can be made by this means than with the ordinary form of target.

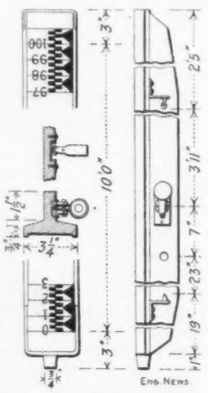

Fig. 1. Bench Level Rod Used on Catskill Aqueduct Line Surveys.

The first work done after the parties were organized was to transfer primary benches from the east side of the Hudson River to the opposite shore, thus establishing a base line of levels for that portion of the aqueduct line lying west of the river. In all, eight benches were thrown across. The parties cooperated in this work, occupying each side of the river in turn, simultaneous readings being taken to eliminate the effects of varying refraction. The width of the river at the point where the levels were carried across is nowhere less than one-half mile. For accurate bisection a strip of paper 1 in. in width was pasted across the regular targets. At each instrument station at least six readings were taken on the distant rod, all of the readings being signalled across to the opposite side. Two complete sets of observations were taken for each bench on two separate days. The following table shows the close agreement between the results of the two independent determinations.

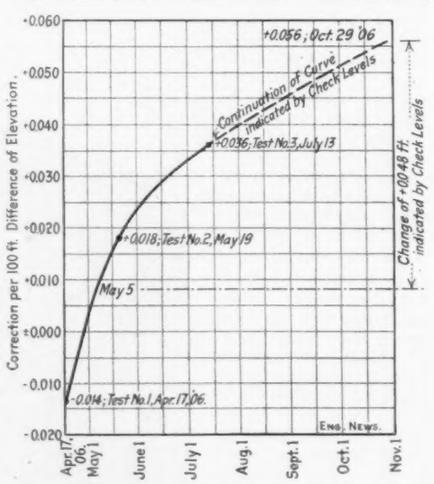

Fig. 2. Corrections for Self-Reading Rods Used on Catskill Aqueduct Surveys.

(Corrections based on measurements and check levels. Comparisons made with 100-ft. steel tape, standardized by Bureau of Standards, U. S. Department of Commerce and Labor.)

TABLE I.—CHECKS ON HUDSON RIVER CROSSINGS.

Location	Discrepancy between two measurements, ft.
Little Stony Point	0.008
New Hamburg	0.007
Camelot	0.011
1¼ miles S. of P'ok	0.001
2 miles N. of P'ok	0.012
Hyde Park	0.010
Staatsburg	0.004
Rhinecliff	0.016

In running the lines of levels with the equipment described, the method employed was in accordance with the usual practice. The limit of discrepancy allowed at the beginning of the work was 0.03 ft. $\sqrt{\text{distance in miles}}$. Progress was necessarily slow on account of the winding roads and steep grades encountered, the average speed attained being approximately 2.0 miles per working day. It was thought that the rate of progress could be increased, and it was therefore decided in the spring of 1906 to put into use self-reading rods and levels provided with three horizontal wires. The instruments adopted were 15-in. inverting Berger levels of the dumpy type, similar to those used in ordinary level work. The principal dimensions of these levels were as follows: Focal length, 13 ins.; diameter of objective, 1¼ ins.; magnifying power, 35; value of one division of level bubble (1-10-in.), 13 seconds.

The two extreme wires in the diaphragm were set equidistant from the middle wire, i : one case being placed at a ratio of 1 : 100. This spacing was found to be too large, as it necessitated a movement of the eye in reading the extreme wires and on grades obviously limited the length of sight. In the other level used the wires were spaced at a ratio of 1 : 200 and gave complete satisfaction.

The self-reading rods (Fig. 1) were of white pine, 10 ft. long, in one length, and divided into feet, tenths and two-hundredths of a foot, readings being estimated to thousandths. In design and general features they were similar to the Molitor rod described in Trans. Am. Soc. C. E., Vol. XLV., p. 14, except that the latter is graduated metrically. The rods first put into use did not have the foot number marked at each tenth. This omission is objectionable, as when all three wires fall between two foot marks all three readings may be read wrong by a foot. The second pair of rods were numbered at each tenth continuously (except between 0 and 1 ft.) and proved very satisfactory. The rods were painted very carefully, and, in accordance with the advice of the makers, were not paraffined, the makers stating that "the paraffine seems to weaken the wood in some way, and after a time it becomes brittle and the rods are apt to break." Measurements of the lengths of the rods were made several times. The curve in Fig. 2 is intended to show the behavior of a pair of rods while in use, as determined by the rod tests and from the results obtained by check levels with the same rods. It may be of interest to know the method used in measuring the lengths of the rods, which was as follows: On a horizontal platform a few inches above the ground a base approximately 50 ft. long was measured very carefully with a standard tape. Points were marked on the base line with spaces between varying from 5 to 10 ft., and on a line parallel to and about 12 ft. distant from the base line, stakes were driven and marked by tacks at right angles to corresponding points marked on base line. Two transits were set up, on the first and second stakes, respectively, and foresight taken to marks on the base line opposite. The rod to be tested was laid on the platform with its front face touching the base line, previously marked by snapping a chalk line, and each transitman read the rod at the point intersected by the vertical wire. The rod was then moved about a foot and a second pair of readings taken. If the intercepts differed by more than 0.002 ft. the readings were repeated. After all the rods were read in this position, transit No. 1 was moved to stake No. 3 and operation repeated for space No. 2, and so on until the whole length of the base line was covered. The difference between the length of base obtained in this manner and the length of base as measured with the tape determined the corrections for the respective rods.

The turning-point pins used with the self-reading rods were identical with those described in Trans. Am. Soc. C. E., Vol. XLV., p. 14.

With the new equipment described above the method was substantially that used on the precise leveling of the U. S. Coast & Geodetic Survey, except that such precautions as were not warranted by the grade of instruments were disregarded. In leveling, all three wires were read on the rod sighted at, and the average of the

three taken for the mean rod reading. The practice of reading three wires has a threefold object: (1) By noting the intervals between the middle and extreme wires a check is obtained on the correctness of the readings. (2) The result reduced from three readings is more accurate than a single observation. (3) The intercepts on the rods enable the observer to balance the lengths of sights.

In detail the method of procedure was as follows: After the instrument was set up and leveled the observer read on the rear rod while the recorder by a very slight pressure of the finger on the leveling plate kept the bubble constantly in the middle of the tube. The observer would call out two of the readings, make a mental note of the third reading and then signal "Right" to the rodman, whereupon the recorder entered the two and then the third reading. The same operation was repeated on the fore rod. If the set of readings on each rod checked, the instrument was carried forward, the rear rodman going ahead of the instrument the proper distance and acting as the forward rodman on the next set-up. As an indication of the rapidity of observation, the parties averaged 30 set-ups per hour (two minutes per station) on continuous steep grades.

The instruments were tested for adjustment at least once a week. One instrument, although in constant use for six months by one of the parties, and subject to the jarring incidental to frequent changes of location and to temperature strains, did not require a single adjustment during that period. The collimation error was usually about 0.001-ft. in a horizontal distance of 50 ft. The second instrument was adjusted when it was received from the maker, and while in use behaved as well as the first. In a hot sun umbrellas were used to shade the instruments.

RESULTS.—Table II. shows the circuit closures for the mean results of the two parties. Some of the circuits are complete loops, the others are runs between the primary bench marks, in this case the "length of the circuit" being the actual distance leveled. In addition to the test of the quality of the levels, as indicated by the circuit closures, the limit of discrepancy allowed between the runs of the two parties, when the new equipment was put in use, was 0.02-ft. $\sqrt{L}$, where L is the distance in miles between bench marks. The total amount of re-run necessitated by this requirement was 7%.

TABLE II.—CIRCUIT CLOSURES.

Circuit	Length, miles.	Closure, ft.	Value of "c" in Eq. Error = $c\sqrt{L}$.
Peekskill	9	—.034	.011
Hunter's Brook	10	—.019	.006
Peekskill—Garrison	11	+.014	.004
Garrison—Cold Spring	6	+.024	.010
Peekskill—Cold Spring	15	—.070	.018
Cold Spring—N. Hamburg	16	—.058	.014
New Hamburg—Camelot	5	+.029	.013
Kingston—Hurley	16	+.063	.016
Highland—Milton	15	—.018	.005
Highland—Ulster Park	17	+.094	.023
Hurley—Olive Bridge	28	+.102	.019
Atwood—Olive Bridge	5	—.012	.005
Atwood—High Falls	13	—.063	.018
High Falls—New Paltz	18	—.052	.013
New Paltz—Springtown	7	+.017	.006
Kingston—Highland	43	—.047	.007
Highland—Cornwall	50	—.168	.024

The results in Table II. show that the leveling accomplished compares favorably with the high-grade leveling executed by the U. S. Government organizations, although no claim is made that the levels are "precise" in the strict sense of the term.

The rate of progress depended almost entirely on the nature of the ground. In comparatively level country the average speed was about four miles per working day, while in the woods, over rugged topography, the speed attained was two miles per working day. As bench marks were established at intervals of about one-fourth mile along the aqueduct line, considerable time was often consumed in finding suitable locations. In running check levels the speed of the parties was usually at the rate of one mile per hour over a straight flat road.

As an illustration of what may be accomplished with the above equipment in leveling along a railroad track, the work of one of the bench level parties, transferred temporarily to Long Island, may be noted. A base line of levels was run along the southern shore over the Long Island R. R., the distance between terminal bench marks being 51.5 miles. The line was run in both directions and where the discrepancy between two runs exceeded 0.02 ft. $\sqrt{L}$ (in miles) that section was re-run. The total divergence between the forward and backward runs was 0.025-ft.; percentage of re-run, 7%; average speed, 6.7 miles of single line per working day.

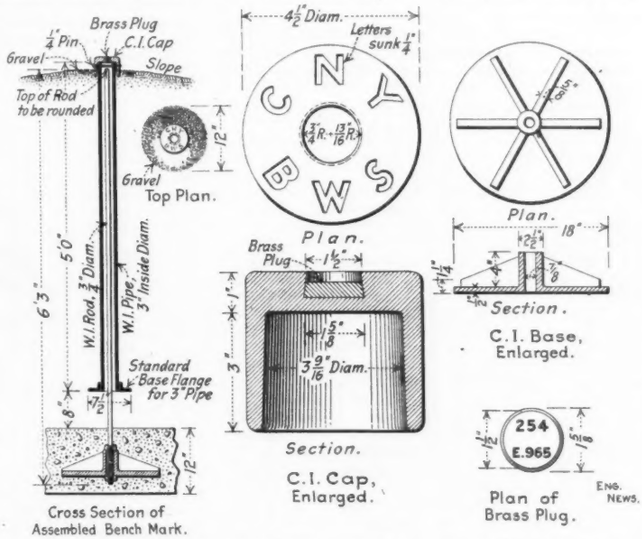

FIG. 3. STANDARD BENCH MARKS, BOARD OF WATER SUPPLY, CITY OF NEW YORK.

(Where ledge rock is convenient, instead of the bench mark shown a ¾-in. wrought-iron bolt, 6 ins. long, upset at the bottom and rounded at the top, is to be set in Portland Cement in the ledge.)

About 70% of the bench marks established along the aqueduct line were spikes in the roots of large trees, the remaining were on ledge or large imbedded boulders. These bench marks are intended to be temporary; the permanent bench marks shown in Fig. 3 are being set for use during construction.

CONCLUSIONS.—As a result of the extensive leveling by various methods and different instrumental equipments, the following conclusions appear to be warranted:

(1) When proper precautions are taken very accurate results may be secured with the ordinary form of dumpy level. Its simplicity of parts and constancy of adjustment makes it superior to the wye level. The results achieved have shown that the accuracy represented by the formula $E = 0.02\sqrt{L}$, where E is the discrepancy in feet between two determinations of the difference of elevation between two consecutive bench marks and L is the distance, in miles, between the bench marks, can be secured with the instrument described without any loss of speed.

(2) For leveling on a large scale a party of four men will produce better results, and in general be more economical, than a three-man party.

(3) Extension rods after being in use for a short time are apt to become defective and introduce errors of accumulative character.

(4) For accurate work, thoroughly seasoned material should be used for leveling rods, and the rods should be measured systematically during the period of leveling to detect changes in their lengths. A steel tape may be used for this purpose, care being taken that the rod and tape are at the same temperature when comparisons are made. The absolute lengths of the rods should be determined at the beginning and end of the leveling. Judging from experience on other work, it would appear that shallow paraffining, that is to a depth of about ⅛-in., is very efficient in rendering the rods moisture proof.

(5) While very good results were obtained with the target rods, they cannot be compared with the self-reading rods for rapidity, and while each of the three wire readings may not be equivalent to a target setting on a long sight, there can be no question that with the result reduced from three-wire readings, a higher degree of accuracy is attained. In city work, where traffic interruptions are apt to retard the progress, the use of the above equipment would have decided advantages over target rods, obviating the loss of time of the latter in setting, reading and checking.

THE WATER HYACINTH.

By G. C. SCHERER.*

For several years navigation has been greatly impeded on the waters of Texas, Louisiana, and Florida, by an aquatic plant known as water hyacinth (Eichornia Crassieps, or Pontederia orassipes) which it is supposed was first introduced into this country near Palatka, Fla., from tropical South America, where it is widely distributed.

Gobel, the German botanist, tells us that "the plant has become a plague to streams, as it frequently almost entirely covers the surface and easily becomes entangled in the ship's screw." Small boats, with propellers, find it impossible to penetrate large masses of the plant, which entirely cover the surface of coves which are protected from the wind, as well as streams where packs are induced by any obstruction whatever. In sharp turns in the narrow portions of streams the plants are caught, thus forming blocks, which sometimes extend for miles, entirely stopping navigation. Even large side-wheel steamers are stopped. The gravest danger, however, threatens small boats which are liable to run into and be sunk by half submerged logs, hidden beneath the luxuriant foliage of the hyacinth.

The hyacinth is also a menace to bridges. The effect of the heavy packs against the piling or bents of a bridge, are more or less dangerous, because of the scour induced, especially where the river bottom is liable to shifting.

Where the water is shallow and the soil loose in texture, the plants are small, and sometimes become rooted to the bottom. They attain full growth only when floating in sluggish streams whose waters are strongly impregnated with humic acid and organic matter. In clear water, or water which contains sulphur, the plant does not thrive.

Cattle are extremely fond of the hyacinth—often wading out almost beyond their depths in its quest. Its soft, pulpy fiber renders an agreeable contrast to the harsh wire grass of the piney woods, but it is thought to create an abnormal appetite, which increases the more the plant is fed upon.

Considering that the water hyacinth contains 92.54% moisture, as analyzed in 1903 by E. E. Ewell, First Assistant Chemist of the Bureau of Chemistry, in Washington, it cannot contain a great deal of nourishment.

The attention of the general Government was first directed to extermination of the hyacinth in 1897, since which time there have been various experiments made under the direction of the War Department—such as spraying with sea water, and running the plants through the rollers of a planing machine. Then followed experiments by spraying with a 50% solution of commercial muriatic acid, sulphuric acid, crude carbolic

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acid and also with kerosene. Then masses of the plant were subjected to a 70-lb. jet of steam. None of these experiments were successful.

In 1903, the Harvesta Chemical Compounding Co., of New Orleans, La., offered a chemical solution for trial, which gave such good results that the War Department authorized the purchase of a small steamer to be fitted with pumps and hose for the purpose of spraying the masses of hyacinth on the St. Johns River, Fla. The successful results obtained by the use of this chemical were so marked that the purchase and equipment of other steamers for use in Louisiana waters was authorized.

These steamers were fitted with pumps for forcing the compound through hose similar to that of a fire engine. The hose was attached to a movable spar, projecting over the bow of the vessel, thus allowing a considerable area to be sprayed. From 24 to 48 hours after the spraying, the plants were dead, and within a short time, sank. By this method the main stream of the St. Johns River, Fla., and a number of its tributaries, were cleared of the hyacinth. The results obtained in the waters of Louisiana were equally satisfactory. This mode of extermination was carried on until 1905, when Congress prohibited the further use of any process injurious to cattle. Further experiments, under the direct supervision of Dr. Charles F. Dawson, Chemist and Veterinarian to the Florida State Board of Health, were then made, to discover an effective chemical means of destroying the water hyacinth which would not be injurious to cattle. The object of the experiments was to determine:

(1) A solution or mixture which should be fatal to the plant.

(2) Whether plants sprayed with such solution would be eaten by cattle.

(3) Whether, if so eaten, the results would be injurious to cattle.

(4) Whether anything could be added to a dangerous solution which would prevent cattle from eating the sprayed plants.

After exhaustive experiments, the conclusions reached were:

(1) Not more than three substances were found which were effective, and practically available as hyacinth killers. These were London purple, arsenite of lime, and arsenite of soda.

(2) Cattle will eat hyacinths sprayed with any effective compound.

(3) All effective compounds are dangerous to cattle.

(4) No practically available substance could be found which, mixed with an effective solution, or applied to the sprayed plants, would prevent cattle from eating the plants.

The spraying method thus being found impracticable, recourse to mechanical means became necessary. The method now in use is to close inlets, sloughs, etc., with booms; to break up the packs with suitable boats and propel them into the current, in order that they may float to more open water. This will, no doubt, be continued, unless some natural enemy of the hyacinth can be found which will completely destroy it.

There is known to exist a parasitic fungus growth which attacks the hyacinth leaves from beneath, forming concentric circles, and in time completely kills the leaves. It would seem that further investigation along this line should be considered.

ORDERS AGAINST STREAM POLLUTION directed to a number of Pennsylvania boroughs and townships have been issued by Dr. Samuel G. Dixon, Commissioner of the State Department of Health. The borough councils of Clifton Heights, Colwyn, Collingdale, Lansdowne, Yeadon, Darby, Glenolden, and Sharon Hill, and the townships of Upper Darby and Darby, have been notified to submit plans for sewerage systems if they lack such, and they have also been notified to provide independent or joint disposal works. The municipalities named, it appears, are located on Darby and Cobb's creeks, but if joint disposal works were built a plant on Delaware River is recommended. Some or all of the communities named must divert their sewage from Darby Creek by Oct. 1, 1908. These orders are in line with a general movement against stream pollution by the department named.

CHEMICAL PRECIPITATION OF WATER AT ST. LOUIS, MO.

The water purifying system of the city of St. Louis has been the subject of two articles in Engineering News; the first (Nov. 26, 1903), treated the changes in the sedimentation basins and the second (Oct. 27, 1904), described in some detail the coagulation basins which had then been in service about a year. During the three years which have elapsed since the appearance of the second article the system then instituted has been in constant use and the details of its action have been subjected to much revision until at present it is thought to be beyond the experimental stage. A complete description of the finished works has recently been presented as a paper* before the American Society of Civil Engineers, by Mr. Edward E. Wall, Assistant Water Commissioner of St. Louis. Though this paper contains much that we have previously published under Mr. Wall's authorship, there are some later developments in statistics and methods of handling the material that are necessary to a complete study of the purification of water by the addition of coagulants.

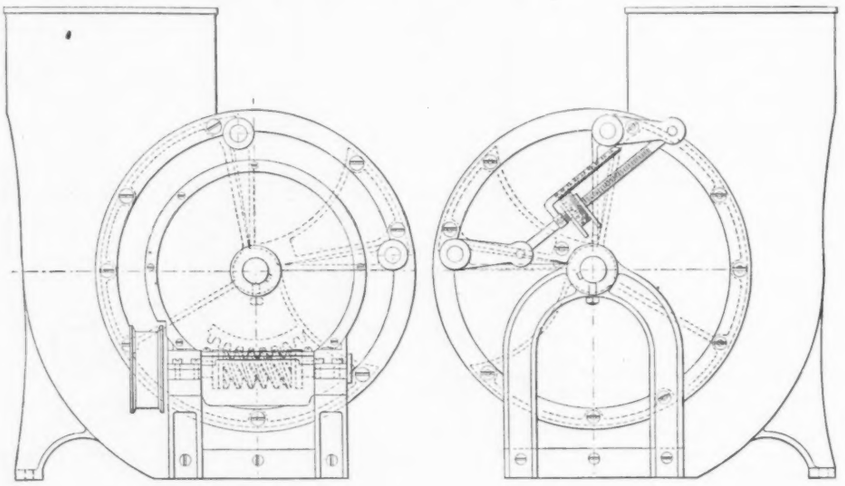
The water of St. Louis is pumped from the middle of the Mississippi River, some ten miles above the city, to a series of six settling basins, from which it is carried into the city. Previous to 1903 the entire purification was carried on by sedimentation in these basins, a process which delivered the water with a reduction of from 10 to 80% in suspended solids and bacteria, both of which are high in the raw water. The betterment of conditions had been under investigation for many years without any successful solution, when in 1903 the coming World's Fair at the city, with its necessary influx of visitors, made it imperative that some immediate action be taken. The best scheme applicable within the short time available seemed to be the use of lime and sulphate of iron as coagulants to hasten and increase the action of the existing sedimentation basins.

Early in 1903 a temporary coagulating plant to use sulphate of alumina had been designed to clarify the water during the period of the 1904 exposition. (Eng. News, Nov. 26, 1903.) After viewing the use of lime and iron sulphate at Quincy, Ill., however, the commissioners decided to adopt those reagents at St. Louis. Accordingly, there was put into operation, in March, 1904, the plant described in our issue of Oct. 27, 1904, which plant has been in operation ever since. The changes in operation since that time are described by Mr. Wall, in his recent paper, as follows:

*Proceedings of Am. Soc. C. E., September, 1907, p. 758: "Water Purification at St. Louis, Mo.," by E. E. Wall, M. Am. Soc. C. E.

The original method of preparing both the iron solution and the milk of lime was not satisfactory from the first. The iron solution, as it came from the tank, varied in strength at times as much as 25% from the normal, due to adding the charges at five-minute intervals while the stream of water flowing through the mass was constant. Evidently as the mass dissolved toward the end of the five-minute period, less sulphate of iron would be exposed to the water, and the solution would be weaker. The extent of variation could be limited by reducing the water supply to the minimum quantity necessary to keep the sulphate dissolved approximately as fast as added, but a simpler and more certain way of maintaining a constant strength solution would be by feeding the sulphate to the tank continuously and evenly. The sulphate of iron is shipped in bulk and is known as "sugar" sulphate. It is similar in fineness to granulated sugar, and when perfectly dry will flow like dry sand. The physical condition of the sulphate is not uniform enough to allow of the use of a standardized orifice, so that it became necessary to design an apparatus for automatic force feeding, which would ensure the measurement of equal volumes, in equal times, and be susceptible of adjustment to various rates of feeding. The range of the apparatus must cover all rates from 2½ to 50 lbs. per min.

The machine shown by the accompanying illustration was designed and built in the Department, and when operated its measurements were found to be absolutely uniform. The machine consists of a cylinder about 12 ins. in diameter and 5 ins. long, with two pockets whose size may be varied by the movement of the side, *a*, which revolves about *C* as a center. This adjustable



Front Elevation. Rear Elevation.

AUTOMATIC FEEDER FOR COAGULATING PLANT AT THE SETTLING BASINS OF THE WATER-WORKS OF ST. LOUIS, MO.

side fits closely to the ends of the cylinder and to the curved side of the pocket. These adjustable sides are moved by the arms, *d*, *d*, which, in their turn, are moved by the micrometer screw, *m*, while the positions of the movable sides are shown by the scale, *s*. The cylinder revolves on the axis, *x*, and is driven by the worm gearing, *g*. The cylinder is partially covered by a casing which serves to hold the full load in the pockets until they reach the position for dumping, and also to prevent the escape of material from the hopper. The cylinder revolves at a constant speed, about 12 revs. per min., and measures and discharges a constant volume of material in equal periods of time.

Tests made to determine the available amount of calcium hydrate carried by the milk of lime, as manufactured by the system of tanks described heretofore, showed that there occurred a heavy loss, amounting at times to as much as 35% of the theoretical value of the quicklime weighed into the tanks. About 3% of this loss is due to impurities in the quicklime, such as sand, dirt, flint and underburned stone. Another portion of loss is due to the air-slaking of the quicklime in transit and in storage. In very warm, moist weather this loss is considerable, but during the greater part of the year it is very small. The greatest part of the loss was found to be due to imperfect hydration, small particles of unslaked lime being carried out of the tanks in suspension. Lowering the velocity through the tanks by reducing the quantity of water, at 120° F., supplied to them, increased the efficiency and raised the temperature of the tank contents. Increasing the temperature of the water supplied to the tanks from 120° to 150° F., without cutting down the quantity, resulted in an increased efficiency of about 15% and raised the temperature in the tanks to almost 200° F.

By supplying the tanks with a quantity of water (at

50° F.) approximately equal by weight to three times the weight of quicklime added, complete hydration resulted with a tank temperature of more than 200° F. This was unsatisfactory because the tank contents became too thick to flow readily through the outlet pipe, and, if not constantly watched, would eventually become so stiff as to stop the stirring apparatus. An addition of too much cold water would reduce the temperature of the tank contents too low for efficient hydration. This led to the idea of utilizing the heat of the effluent from the tanks for heating the water supply. This was accomplished by the addition of an auxiliary tank into which the milk of lime is conducted from the several slaking tanks. This auxiliary tank contains a coil through which the cold water flows on its way to a head tank, from which the supply is piped to the slaking tanks. The head tank is equipped with a float valve to regulate the flow of incoming water, so that a constant head is kept on all the feed pipes leading to the slaking tanks. Each feed pipe has, at its lower end, an adjustable orifice to regulate the quantity of water supplied to each tank, so that the quantity of water entering each tank is from 3½ to 3¾ times as much by weight as the lime added to that tank. The temperature of the tank contents is over 200° F., and that of the water in the head tank about 100° F., varying with the temperature and quantity of the cold water entering the coils. This arrangement has been in service for several months and has shown a decided reduction in the expense of operation.

Table I. gives the quarterly statistics of the plant during the past three years, as presented in the text by Mr. Wall. It is estimated that the population has increased from 575,000 in 1900 to 700,000 in 1907.

Mr. Wall continues:

The gradual increase in the cost of purification is due to several causes. During the first year we were proceeding cautiously and often used quantities (both of sulphate of iron and of lime) too small to produce efficient coagulation and settlement. The water as drawn from the settling basins was often turbid and nearly always cloudy. It was not until the latter part of the first year that the efficiency of the treatment began to approach the results which were obtained during the third year. We were also afraid of having caustic lime in the effluent, and, at that time, had not devised any definite method of determining the quantity of lime which it would be safe to add, and in trying to avoid the error of using too great a quantity, we naturally fell into the mistake of adding too little. The increase in cost per 1,000,000 gals. during the third year was due principally to the fact that the price of lime was raised from $3.88 to $4.65 per ton. The average quantity of lime added, in grains per gallon, was greater during the third year on account of the longer period of very turbid water in the river, and because of greater accuracy in proportioning the proper quantity of lime necessary each day and a consequent production of a continuous supply of pure and clear water.

The maximum quantity of sulphate of iron added to the water on any occasion during the third year was 3.75 gr., the minimum being 1.25 gr. per gal. of water treated; of lime, the maximum was 11 gr., and the minimum, 3 gr. per gal. of water treated. These figures are calculated on the weights of sulphate of iron and lime as taken from the bins, but, in the case of the lime, the actual efficient quantity is much less than the record shows, on account of deterioration in transit and in storage from air-slaking; for example, in the case of the 11 gr. mentioned, the actual amount of efficient lime, as determined by analysis, was 7.7 gr. This explains why the average for the year in grains per gallon is as high as 7.39; the average of efficient lime added would be considerably lower. The sulphate of iron does not deteriorate appreciably in storage.

The alkalinity of the treated water during the third year varied from 35 to 75 parts per million, the average being 49. The increase of incrustants through the action of the sulphate of iron averaged 13 parts per million, calculated as calcium carbonate. The softening actually accomplished by the treatment is a reduction of the lime carbonate to 53% of that in the raw water, and of the magnesia to 57%; the average of 204 determinations each, of the amounts of calcium and magnesium in the raw water, were 42.3 and 13.1 parts per million, respectively; in the treated water, 22.8 and 7.54 parts per million.

During each day as often as conditions require, samples are taken from each basin, and the caustic alkalinity of each sample determined by titration. Throughout the basins the caustic alkalinity is kept as low as is consistent with efficient coagulation, the aim being to keep down the charge of lime until the last basin shall show little or no caustic alkalinity. It is not possible to maintain any uniform set of conditions throughout the basins on account of the great and sudden fluctuations in the quality of the river water. The quantity of lime added being controlled in this way, the changes in the amount of sulphate of iron necessary are determined from the appearance of the coagulation and from the condition of the water in each basin, turbidity determinations being made from a portion of the samples taken for testing the caustic alkalinity.

Practically all the chemical and bacterial work on the raw and treated water during the first two years of operation was done outside of the Department by the City Chemist and the City Bacteriologist, and under the direction of the Board of Health.

Special tests, taking daily samples for from 10 days to 2 weeks, for the purpose of determining the presence of B. Coli Communis have been made at various times and by different observers. Except in one or two doubtful cases the total absence of B. Coli in the tap water was established beyond any reasonable doubt.

Table II. gives the typhoid statistics from 1900 to March, 1907. The record for 1904 must be read, bearing in mind that the purification process was not started until April and that 1904 was the year of the World's Fair in St. Louis, which temporarily increased the population by many thousands, and, under the conditions prevailing in previous years, an increase in the number of cases and deaths from all diseases could reasonably have been expected. The typhoid rate was 29.4 per 100,000 in 1900, increasing to more than 40 per 100,000 in 1903, and then decreasing to 16 per 100,000 in 1906. This, in itself, does not express the total beneficial effect on the general health arising from the use of pure water. Allen Hazen, M. Am. Soc. C. E., estimates that where one death from typhoid has been avoided through an improved water supply, probably two or three deaths from other diseases have been avoided. The following record seems to indicate a higher proportion of decrease than Mr. Hazen's estimate would give:

ANNUAL MORTALITY RECORD, ST. LOUIS, MO., 1900 TO 1906, FROM DISEASE ALONE.

1900	9,217	1904	10,695
1901	9,916	1905	9,545
1902	9,654	1906	9,214
1903	10,320		

NEW COAGULANT HOUSE.—The coagulating plant which has been in use for more than three years was originally built as a temporary affair, with the expectation that it would be replaced by a permanent structure after the World's Fair in 1904. The cost of this temporary coagulant plant, with all machinery and connections, was less than $10,000. The cost of changing the settling basins, necessary to put in operation the purification scheme, amounted to about $25,000.

When the process was put into operation, however, defects and new problems presented themselves in rapid succession and it soon became evident that a design for a permanent plant would have to await the solution of some of these problems. After three years of study and experiment, plans and specifications have been prepared for a fireproof building, equipped with crushers, conveyors, elevators, feeders, mixing-tanks, etc. The contract for this building was let on June 11, 1907, for the sum of $89,500, to be completed by Jan. 1, 1908.

The building will contain eight circular bins, of 20 ft. inside diameter and 40 ft. high, for the storage of sulphate of iron and lime. These bins will have a capacity of 10,600 cu. ft. each, providing for the storage of about 160 days' supply of sulphate of iron and about 45 days' supply of lime, at the present rate of use.

The lime bins will be practically air-tight to prevent deterioriation while in storage. In April, 1906, a small bin, 6 × 6 × 6 ft. interior dimensions, was built of wood with double walls, the space between filled with pitch to one-half the height, the upper half being lined with tar paper covered with pitch. This bin was filled with lime, and sealed. A careful watch was kept for signs of heating, but up to June 1, 1907, no evidence of deterioration had been found. In August, 1906, another bin of the same size was built of concrete 6 ins. thick, and filled with lime. No damage has occurred to the lime in this bin after ten months' storage. Both these bins have stood exposed to the weather, without any protection, ever since they were built.

The bins in the new building will be constructed of reinforced concrete, faced on the outside with brick. [The bins have sloping bottoms, with circular discharge holes located at one side of the axis of the bin—Ed.] The central part of the building will be of brick, and divided into three floors, viz., the basement floor, where the crushers and a portion of the conveying machinery are installed; the pump floor, containing the heater tanks and pumps; and the mixing floor, where the mixing tanks and daily supply hoppers with all their appurtenances are located. The motive power for crushers, conveyors, elevators, mixers, etc., will be electricity on a 500-volt circuit. All motors will be of the latest type, having commutating poles, and will be operated from one switchboard.

The daily supply hoppers will have a capacity of 900 cu. ft. and will be supported on four pairs of helical springs. Each spring will carry a safe load of 10,000 lbs., and deflect ½-in. under a load of 1,250 lbs. The purpose of having this hopper move vertically is for automatic control of the conveyors feeding the hoppers. When the hopper is full, it will stand at its lowest elevation, but as the contents are withdrawn the hopper will rise, and, on reaching a certain point, will automatically switch in the current driving the motors which operate the feeding conveyors. As the hopper becomes filled again, it descends and again cuts off the current, stopping the feeding conveyors.

The lime is fed from its daily supply hopper into automatic scales, each of which dump the required amount into its tank, at regular intervals, varying from one to four minutes. The scales are designed to weigh any amount from 30 to 120 lbs. at a single load, the frequency of dumping also being adjustable between intervals of one and four minutes, the two adjustments giving quantities varying at the rate of from 10 to 80 lbs. per min.

The sulphate of iron is delivered from its daily supply hopper into the solution tanks by the feeders previously described.

The milk of lime flows from the mixing tanks into one of the heating tanks on the pump-room floor, and thence to the collecting tank from which it is taken by the pumps. The collecting tank is supplied with a varying quantity of cold water, controlled by a float valve, for

TABLE I.—QUANTITY STATISTICS—ST. LOUIS WATER PURIFICATION.

	Exposition Year. 1904-05.	1905-06.	1906-07.
Total quantities in tons:			
Iron sulphate	3,578	4,138	4,050
Lime	14,291	11,814	14,081
Total water treated, million gals.	33,133	26,334	26,682
Average daily water consump., gals.	79,052,000	69,000,000	70,109,000
Average quantities per gal. water:			
Grains—Iron sulphate.	1.5	2.2	2.13
Grains—Lime	6.0	6.28	7.39
Average cost per million gals. water:			
Lime	1.89	1.74	2.45
Iron sulphate	1.07	1.53	1.44
Labor	0.57	0.62	0.58
Power	0.07	0.09	0.07
Repairs	0	0.01	0.08
Total	3.60	3.99	4.62

TABLE II.—CASES AND DEATHS FROM TYPHOID FEVER IN ST. LOUIS SINCE JANUARY 1, 1900.

Months.	1900. C.	1900. D.	1901. C.	1901. D.	1902. C.	1902. D.	1903. C.	1903. D.	1904. C.	1904. D.	1905. C.	1905. D.	1906. C.	1906. D.	1907. C.	1907. D.
January	57	19	76	8	103	14	81	15	65	19	20	5	28	7	12	5
February	42	5	55	14	52	16	55	15	37	7	14	6	17	5	15	6
March	117	16	32	11	34	11	91	20	61	20	19	4	18	6	14	2
April	34	4	24	4	48	14	79	17	38	12	18	1	17	5	..	..
May	20	4	32	8	38	11	86	15	56	18	32	9	12	3	..	..
June	26	8	26	6	28	7	90	16	25	6	15	6	14	3	..	..
July	43	15	49	13	83	14	189	26	65	23	59	18	50	8	..	..
August	119	20	185	31	88	26	221	37	178	30	130	24	154	16	..	..
September	253	13	138	24	169	21	261	42	180	36	163	17	125	29	..	..
October	262	30	205	32	194	32	183	30	99	24	105	23	101	14	..	..
November	127	15	154	27	169	31	131	23	44	17	63	7	50	11	..	..
December	104	19	125	20	106	25	119	31	24	13	36	6	24	5	..	..
Totals	1,213	168	1,101	198	1,112	222	1,586	287	872	225	674	126	610	112	..	..

C. = Cases. D. = Deaths.

TABLE III.—AVERAGE PERCENTAGES AND REDUCTION BY MONTHS.

Parts per 1,000,000.

Date.	Solids—Suspended. River.	Solids—Suspended. Tap.	Solids—Dissolved. River.	Solids—Dissolved. Tap.	Bacteria per c. c. River.	Bacteria per c. c. Tap.	Bacteria per c. c. % Removal.
Apr. 1904.	2,400	130	180	160	126,500	22,940	86.0
May	1,548	65	206	161	57,000	5,850	93.0
June	3,372	39	206	165	27,000	1,050	96.0
July	2,483	48	212	144	26,000	323	98.7
Aug.	1,290	40	257	170	15,180	817	95.0
Sept.	1,000	15	228	177	14,200	225	98.2
Oct.	460	13	201	194	.....	.....	....
Nov.	228	9	320	195	24,300	4,050	82.5
Dec.	256	9	352	227	48,250	4,587	90.5
Jan. 1905.	79	16	414	242	20,000	1,857	90.7
Feb.	29	4	406	280	39,350	1,341	96.5
Mar.	942	9	225	180	33,700	1,910	94.4
Apr.	440	6	206	156	66,080	2,200	96.8
May	965	30	273	234	15,130	900	94.0
June	1,040	15	231	158	32,310	619	98.4
July	2,606	41	233	182	91,000	1,750	98.2
Aug.	1,746	24	216	165	40,400	400	99.0
Sept.	1,125	16	218	185	32,400	350	98.9
Oct.	730	15	224	156	53,820	390	99.3
Nov.	395	10	248	155	46,250	1,803	96.0
Dec.	388	10	316	185	48,520	848	98.4
Jan. 1906.	496	7	234	151	144,420	1,810	98.7
Feb.	250	6	247	144	47,220	1,164	97.5
Mar.	858	3	166	118	66,560	202	99.7
Apr.	718	4	200	148	.....	.....	....
May	625	14	222	151	.....	.....	....
June	3,218	4	274	199	.....	.....	....
July	2,162	6	243	219	.....	.....	....
Aug.	1,278	3	235	170	.....	.....	....
Sept.	891	3	234	167	.....	.....	....
Oct.	670	4	264	175	.....	.....	....
Nov.	528	2	293	201	30,980	2,280	92.6
Dec.	296	4	292	195	.....	.....	....
Jan. 1907.	1,147	2	218	185	44,700	428	99.1
Feb.	430	3	231	144	30,200	680	97.5
Mar.	1,578	2	206	174	44,030	36	99.9

the purpose of cooling and diluting the milk of lime, and also for increasing the volume of dilute milk of lime, so that the pumps shall not empty the tank at any time because of the varying quantity of milk of lime flowing from the mixing tanks, or because of the variable speed of the pumps themselves on account of variation in voltage of the current supplied.

The lump lime is unloaded from the car into the crushers on the east side of the building. It is crushed to ½-in. and smaller, and carried by a system of conveyors and an elevator to the storage bins, which runs above the lime storage bins and dumps into these bins through doors provided for that purpose.

In taking lime from the bins for daily use, the crushed lime feeds by gravity into a conveyor and thence to an elevator which carries it up to the lantern and delivers it to the daily supply hopper. A similar plan is followed by the sulphate of iron. As before mentioned, the motors driving the conveyors and elevators feeding the daily supply hoppers will be started and stopped automatically by the vertical motion of the hoppers. The daily supply hoppers will each carry from 50,000 to 60,000 lbs. of material, which is sufficient for from 2 to 2½ days' supply of sulphate of iron, and from 16 to 20 hours' supply of lime, at the present rate of use.

In case any of the machinery feeding the daily supply hoppers breaks down, provision is made for drawing either sulphate of iron or lime, or both, from the bottoms of the bins into small cars on the basement floor, from which they will be elevated by a freight elevator, to the mixing floor, when the tanks will be fed by hand, as is being done at the present time.

The cost of operating the new plant is estimated at $17,000 per year, including interest and depreciation, as compared to $21,500, which has been the average cost of operation for the past three years. The actual yearly cost of operation alone of the new plant will be at least $9,000 less than that of the original plant.

There are now being built two new settling basins, Nos. 7 and 8, having a capacity of 75,000,000 gals., at a cost of about $500,000. These basins are constructed with reinforced concrete walls of sections, backed with clay puddle 18 ins. thick. The floor is covered with 9 ins. of concrete, in blocks 8 ft. square, on 18 ins. of clay puddle, the joints between the blocks being filled with an asphalt filler.

With these basins in service and the improved facilities for uniform treatment afforded by the new coagulating plant, there is no reason to doubt that St. Louis will be supplied with water as agreeable to the eye and as pure and wholesome as is enjoyed by any city in the United States.

In the discussion of this paper before the society the methods of handling the chemicals at the St. Louis plant were highly commended, but the statistics quoted by Mr. Wall to justify the system were subjected to considerable criticism.

Dr. George A. Soper, M. Am. Soc. C. E., said that although the St. Louis plant was far in advance of any other similar work, the assumptions of its near approach to perfection in water purification are far from being justified; it will be a long while before its exact sanitary value can be estimated. The use of chemicals to purify water is somewhat dangerous, owing to the frequent presence in the coagulating material of some poisonous element, generally too small to be harmful, but always bearing a potential danger. Dr. Soper deplored the use of the typhoid statistics to prove the efficiency of purification. Not only are physicians often lax in reporting typhoid, but in many cases similar diseases are reported as typhoid, as the diagnosis of the disease is frequently indeterminate. Then again the basis of all typhoid statistics is the population, which in this city, as in all others, is rarely accurately reported except in the decennial federal census. However, if all cases of typhoid were reported, with no other disease miscalled, and the basis of population were correct; in other words, if the typhoid mortality (which in the St. Louis reports bears too high a relation to the morbidity) were correctly analyzed, even then such statistics are of small value in determining the efficiency of a water purification system. The recent reports in Washington have emphasized the fact that typhoid is due, in a large proportion of cases, to causes other than impure water: to milk, oysters, vegetables, flies, etc., which causes should have been thoroughly investigated and reported on before presenting typhoid statistics as a proof of purified water.

Mr. George C. Whipple, Assoc. M. Am. Soc. C. E., called attention to the fact that this was the first extended use of chemical purification as a final process. He thought that the St. Louis engineers took too rosy a view of the future as to the ultimate perfection of the plant. The old sedimentation was higher in efficiency than the paper seemed to indicate and ten years ago the typhoid was as low, if not lower, than it is now; a fact omitted in the typhoid tables. The turbidity tables do not show a "clear and sparkling" water as claimed in the paper, and to be quite correct, should have given daily tests instead of monthly. Once when the monthly average of turbidity was 39, a record for one of the days was 400. One fault of the chemical system was not mentioned: the tendency toward a deposit of calcium carbonate in the pipes and in the meters. The extent to which this has gone in St. Louis should have been noted.

MACHINERY AND POWER REQUIRED FOR THE PRODUCTION OF PAPER PULP, MECHANICAL AND CHEMICAL, AND FINISHED PAPER.

By JOHN W. THURSO, C. E.*

Engineers, when called upon to determine the power required for a given output of ground wood, sulphite or newspaper, find it difficult to obtain reliable data for this purpose and the writer has therefore given, in what follows, the information necessary to make a complete estimate of the necessary machinery, including engine and boiler equipment. These data have been collected from the writer's practice during the past 12 years and from various successful plants in the United States and Canada.

Spruce wood is used chiefly for newspaper making and the spruce forests of the northern parts of the United States and Canada will yield from five to eleven cords of pulpwood per acre, or from 3,200 to 7,040 cords per sq. mile. In considering this figure it should be borne in mind that wood for paper-making runs between about 8 and 16 ins. in diameter. Logs larger than 16 ins., at the small end, go to the sawmill, as they will thus yield larger profits. Logs smaller than 8 ins. at the large end are usually left to waste except when the supply becomes scarce. Pulp-wood must be perfectly sound and straight; crooked pieces cannot be barked.

Where the wood supply depends on water transportation (floating), sufficient wood must be stored to last over the cold season. It is customary in the localities named to provide a supply for 155 to 170 days for the ground-wood mill and for 310 to 340 days for the sulphite mill. The difference in time is due to the fact that the wood for grinding should be saturated with water to produce the best fiber and to require the least power for the operation, while wood for sulphite making should be as dry as possible, to require the least time for cooking. In computing storage capacity it may be assumed that pulpwood logs, well piled, will require a space of 140 cu. ft. per cord. Some mills to save in cost of railroad transportation, receive their pulpwood already barked.

One cord of unbarked wood will give on an average 0.85 cords of barked wood.

In arranging the accompanying tables of machinery required for wood-pulp, sulphite-pulp and paper mills, it is assumed: (1) that the wood-preparing plant runs only 10 hrs. per day, as it is considered dangerous to work around the log piles at night and as in winter it often requires blasting to loosen the logs; (2) that all grinders are direct-connected to hydraulic turbines; (3) that each paper machine with its pump, screens, chest, etc., is driven by a separate hydraulic turbine, steam engine or electric motor; (4) that all other machinery is driven by turbines, engines or motors through shafting; (5) that all water entering the manufacturing process requires filtering; (6) that log-hauls and chip-conveyor are to be about 500 ft. long; conveyors to storehouses about 300 ft. long; block-conveyors about 125 ft. long. (As most of the power required by log-hauls and conveyors is lost in friction, small plants will require comparatively more power than given here.)

In giving the number of barking and chipping machines required, allowance has been made for the necessary stoppages to exchange dull knives for sharp ones.

An extra pressure pump has been provided for grinders to allow for break downs.

The number of hydraulic presses for reducing the water contents in the ground wood and sulphite to 50% depends entirely on the design and capacity of the presses chosen.

A digester of each of the sizes named will give 10 tons of sulphite per charge. Its capacity in 24 hrs. will depend on the time required for cooking. This time will be the less, the stronger the sulphurous acid, the dryer the wood and the higher the steam pressure.

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TABLE I.—MACHINERY FOR GROUND-WOOD PULP MILL OF 100 TONS CAPACITY PER DAY REQUIRING 112 CORDS OF UNBARKED SPRUCE WOOD PER DAY.

		HP. required to operate.
	Wood Preparing Plant:	
1	Log haul	20
1	Gang saw	15
1	Block conveyor to barking machines	4
10	5-ft. barking machines (9 running, 1 reserve), 15-HP. each	135
1	Splitter	3
1	Block conveyor to grinder building	5
	Pulp Mill:	
22	54 x 27-in. three-pocket grinders, 4.55 tons capacity each, requiring 75 HP. per ton	7,500
3	Triplex pressure pumps (2 running, 1 reserve), 8-HP. each	16
1	8-in. centrifugal stuff pump	18
1	6-in. centrifugal white water pump	12
20	12 plate screens, coarse, 3-HP.	60
25	12 plate screens, fine, 3-HP.	75
1	Pump, raising water 80 ft. to filters (20,000 U. S. gals. per ton)	40
1	8-in. centrifugal stuff pump	15
	Total HP. (*a*)	7,918
	Additional Machinery for Making Pulp into Sheets, 50% Dry, for Storage or Sale.	
20	Wet machines, 72-in. face, 12-HP.	240
1	Waste pulp dissolver	3
1	Triplex pressure pump for hydraulic presses.	8
1	Conveyor to storehouse	12
	Total additional HP. (*b*)	263
	HP. required for capacity of 100 tons ground-wood sheet pulp per day (*a*) + (*b*)	8,181
	Additional Machinery for Making Pulp Ready for Immediate Manufacture into Paper:	
14	Single (or 7 double) cylinder washers, 3-HP. (or 6-HP.) (*c*)	42
	HP. required for capacity of 100 tons pulp ready for paper making per day (*a*) + (*c*)	7,960
	Boiler capacity required for heating in winter about	30
	Boiler HP. produced from shavings, refuse, etc., about 3-HP. per cord, for 112 cords per day	350

TABLE II.—MACHINERY FOR SULPHITE MILL OF 100 TONS CAPACITY PER DAY, REQUIRING 182 CORDS OF UNBARKED SPRUCE WOOD.

		HP. required to operate.
	Wood Preparing Plant:	
1	Log haul	30
1	Gang saw	20
1	Block conveyor to barking machines, etc.,	5
16	5-ft. barking machines, 15-HP. (15 running, 1 reserve)	225
1	Splitter	4
1	Block conveyor to chippers	5
3	7-ft. chippers, 75-HP., 1 runs part of time only (1-HP. per cord)	225
2	5-ft. crushers, 50-HP., 1 runs part of time only (½-HP. per cord)	100
2	Chip screens, 4-HP.	8
1	Chip conveyor (or blower) to bins	20
	Sulphite Mill:	
1	Pump, raising water 80 ft. to filters (20,000 U. S. gals per ton)	40
1	Limestone elevator for acid tower	8
1	Triplex pump for acid tower	8
4 or 5	Digesters, each 15 ft. diam. x 42 ft. high or 14 ft. diam. x 45 ft. high	...
1	8-in. centrifugal stuff pump	15
6	Copper-worm washers, 3-HP.	18
3	Tumbling barrels, 5-HP.	15
2	Knot screens, 5-HP.	10
1	8-in. centrifugal stuff pump	15
25	12 plate screens, coarse, 3-HP.	75
35	12 plate screens, fine, 3-HP.	105
12	Copper-worm washers, 3-HP.	36
1	8-in. centrifugal stuff pump	15
	Total HP. (*d*)	1,002
	Additional Plant for Making Sulphite Sheet Pulp:	
10	Wet machines, 72-in. face, 12-HP.	120
1	Waste sulphite dissolver	4
1	Triplex pressure pump for hydraulic presses	8
1	Conveyor to storehouse	12
	Total additional HP. (*e*)	144
	HP. required for capacity of 100 tons sulphite sheets per day (*d*) + (*e*)	1,146
	Additional Machinery for Making Sulphite Pulp Ready for Immediate Manufacture into Paper:	
3	Felt machines, 72-in. face, 12-HP. (*f*)	36
	HP. required for capacity of 100 tons of sulphite pulp ready for paper making (*d*) + (*f*)	1,038
	Boiler HP. required for digesters (20 HP. per ton of sulphite pulp)	2,000
	Boiler HP. required for heating in winter	30
	Boiler HP. produced from shavings, refuse, etc. (about 3-HP. per cord), from 182 cords	550

TABLE III.—MACHINERY REQUIRED FOR PAPER MILL CAPACITY OF 100 TONS PER DAY.

Good newspaper contains about 80% of ground wood pulp and 20% of sulphite. Wood required per day, 89.6 for ground-wood and 36.4 cords for sulphite pulp; total, 126 cords of unbarked spruce.

		HP. required to operate.
10	Beating machines, 40-HP.	400
4	5-in. centrifugal pumps, 8-HP.	32
4	Jordan stuff refiners, 45-HP.	180
4	Paper machines, including chests, triplex stuff pumps, centrifugal pumps, screens, suction pumps, slitters, cutters and blowers (13-HP. per ton)	1,300
2	Freight elevators, 6-HP.	12
1	Clay breaker	4
2	Clay tanks with agitators, 5-HP.	10
1	Conveyor to storehouse	12
1	Pump, raising water 80 ft. to filters (20,000 U. S. gals. per tons)	40
	Total HP. required in addition to that shown in Tables I and II. (g)	1,990
	Add 80% of 7,960 HP. (plant making ground-wood pulp ready for paper making)	6,368
	Add 20% of 1,038 HP. (plant making sulphite pulp ready for paper making)	208
	HP. required for capacity of 100 tons newspaper per day	8,566
	Boiler HP. required for dryers of paper-machines (5 HP. per ton)	500
	Boiler HP. required for heating in winter	30
	Boiler HP. produced from shavings, refuse, etc. (about 3-HP. per cord), for 126 cords	400

Each ton of paper per day requires about 4.5 to 4.75 ins. of width of paper machines. A 100-ton plant might, for example, use machines as follows: 1 — 90 ins. wide = 300 HP.; 1 — 110 ins. wide = 320 HP.; 1 — 120 ins. wide = 330 HP., and 1 — 147 ins. wide = 350 HP.

Table V. shows the entire hydraulic-turbine capacity that must be provided to supply power to a newspaper mill of a capacity of 100 tons per day and to the necessary auxiliary works and village incident to the industry. It should be noted that the first item of this table, taken from Table III., represents 80% of the HP. required for the machinery of a 100-ton ground-wood mill, 20% that for a 100-ton sulphite mill and 100% that for a 100-ton paper mill alone. The figures of auxiliary HP., given in Table IV., apply equally to each of these three classes of mills and as Table V. is formed from 80% the requirement of the first class, 20% that of the second and 100% that of the third class, this equals 200% the figures of Table IV.

All figures relate to 24-hr. production of final material. All weights are given of dry materials.

The different items in above lists are given, as far as possible in the same sequence as the steps of manufacture follow each other.

Sulphite mills usually operate continuously, ground wood and paper mills usually from Sunday 12 p. m. continuously to Saturday 12 p. m., with the exception of the wood preparing, as has already been stated.

TABLE IV.—POWER REQUIRED FOR PLANTS AUXILIARY TO GROUND-WOOD, SULPHITE PULP AND NEWSPAPER MILLS.

	HP. required per 100 tons capacity of each, ground-wood, sulphite and paper mill.
Machine, pattern and blacksmith shops	30
Miscellaneous (headgates, forced draft, ash and coal conveyors, boiler feed pumps, water-works for mill, village, etc.)	100
Electric lighting system (turbine capacity):	
For mill	17
For mill village	28

TABLE V.—TOTAL MOTIVE POWER FOR PAPER MILL PLANT OF 100 TONS CAPACITY PER DAY, INCLUDING THE POWER REQUIRED BY THE NECESSARY GROUND-WOOD AND SULPHITE MILLS AND FOR VILLAGE.

HP. from Table III.	8,566
HP. from Table IV.:	
Shops	60
Miscellaneous	200
Electric light	90
Total HP.	8,916
Total HP. required per ton capacity	89.2

TABLE VI.—HP. BOILER CAPACITY REQUIRED FOR A PLANT, AS IN TABLE V., CAPACITY OF 100 TONS OF PAPER PER DAY.

Digesters (20% of 2,000 HP., Table II.)	400
Dryers of paper machines	500
Heating in winter	60
	960

Of this 960 HP., 400 will be produced from waste materials and 560 HP. must come from coal or other fuel.

ANNUAL MEETING OF THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS.

The 24th annual meeting of the Connecticut Society of Civil Engineers was held at New Haven, Conn., on Feb. 11 and 12. This association, founded in 1884, is one of the oldest, if not the oldest, of the many state engineering societies which now represent nearly every state in the Union, the infant Oklahoma being even numbered in the list. The Connecticut Society is in a very flourishing condition as regards members, with a total roll of 284. In a financial way it is, however, not now in so prosperous a condition as in some former years, the excessive cost of the publishing of last year's papers both in advance copy and final having depleted the treasury to a considerable extent. The present meeting lasted over one day and a half of the next and comprised a business session, numerous excursions, nine papers with discussions, a luncheon tendered by the New Haven members and a banquet and entertainment. Over 100 members and guests were in attendance.

At last year's session a committee was appointed to investigate the desirability of the adoption of an engineering code of ethics, the principal feature of which was to be the recommendation to the Connecticut legislature of a law requiring the examination and registration of engineers after the manner now universally in vogue in the legal and medical professions. It was also suggested at that time that a fixed list of charges for various engineering services be made out and that every engineer should adhere to it in his work. This committee reported this year that after consideration of the subjects suggested they had decided such a code or rate card inadvisable. The committee was therefore discharged and the proposition vetoed.

After the business session a party was made up to inspect the new Hammond Metallurgical Laboratory at the Sheffield Scientific School of Yale University. This laboratory, recently presented by Mr. John Hays Hammond, President of the American Institute of Mining Engineers, has one of the most complete equipments in the country for the analysis and production of metals from the ore, all of the machines being full size such as are found in actual working practice.

SAND FILTRATION OF WATER.—The principal paper of the session was by Mr. William B. Fuller, M. Am. Soc. C. E., of the New York City Board of Water Supply, on "The Purification of Water by Sand Filtration." Mr. Fuller said that the one item that has tended to retard the increasing use of slow sand filters was the cleaning of the beds. In this respect the mechanical filters have an immense advantage and it is along this line that most of the future study of filtration must be made. Increasing the efficiency of the filters by running up the rate of filtration can avail nothing if the cleaning time still stays the same. Thus, if a plant now filtering enough water in 23 days to necessitate cleaning, this taking 2½ days, is so improved that the same amount of water can be treated in say 15 days—with necessarily the same length of time for cleaning, since the same amount of dirt will collect—reserve filters to take care of the water during cleaning of the others will have to be placed to take 16% in the improved system against only 10% in the original. The first cost and the maintenance of this larger system will offset the gain by more rapid filtration. This subject, then, has been especially studied by the Board of Water Supply of New York City in connection with the new filtration system which they are now designing and a test filter bed has been built upon which various schemes for cleaning the dirty sand have been tried.

Outside of the methods more generally in use on the large plants in this country and abroad, two schemes were more particularly watched. In the first the water on the bed is lowered until about one inch is left on the sand. Upon this surface a 1-in. stream of water is played and the sand meanwhile agitated with rakes and the dirt washed away. The time lost in lowering the water was very great and the process did not seem to promise well. The other method, according to Mr. Fuller, is the best that has yet been tried, and will in time, if developed properly, revolutionize the operation of slow sand filters. This is the Blaisdell patented process now in use in Yuma, Ariz., and other western plants. In this system a frame, carrying an agitating wheel which penetrates below the water in the filter to the sand, is made to travel on supports fixed in the structural portion of the filters. This agitating wheel is a hollow wheel held in a horizontal plane from a hollow vertical shaft, and carrying, on its circumference, small nozzles. In operation the wheel is thrust into the sand to the depth of the dirt and power applied so as to make the wheel revolve, the whole apparatus move ahead and a head of water to be forced out of the nozzles. This wheel is contained in a box which fits down tight in the sand and a suction pump draws out of this box the dirt which is stirred up by the wheel. In a six months' trial at the experiment station this machine has been remarkably efficient. It works very rapidly so that a smaller reserve area is needed.

WATER WASTE INVESTIGATIONS.—Messrs. William E. Johnson and Ermon E. Peck, of Hartford, presented a paper under the above title in which they noted the effect upon per capita consumption of water made by the installation of water meters in Hartford. After a severe water famine in 1899 the engineers in that city investigated the water uses and decided that there was an immense waste of water which could be controlled by the use of water meters. Accordingly in 1900 they commenced to install meters, and the following table shows the result upon the per capita consumption in gallons per day:

Year.	No. of services.	No. of meters.	Per capita consumption, gals. per day.
1900	8,951	550	84.6
1901	9,256	2,783	76.3
1902	9,514	6,993	78.8
1903	9,683	9,156	75.0
1904	9,809	9,604	66.7
1905	10,006	9,880	62.6
1906	10,328	10,137	61.6
1907	10,623	10,433	59.1

The rise in 1902 is explained by the fact that the expected rise in rates due to the use of meters did not materialize and the people became careless in their use of water. There is now in Hartford an estimated population of 113,000, including 4,000 transients, and there are 10,922 water services and 10,814, or about 99%, water meters. Along with the metering of the house services a rigid leak inspection bureau has been established, and this is thought to have been of large value in the reducing of the consumption.

HARBOR AND RIVERS OF NEW HAVEN.—Mr. J. Frederick Jackson, Secretary of the society, delivered an historical description of the waterways and accompanying structural works in and about New Haven, paying more particular attention to the improvement of the harbor by the United States Government. The shipping in New Haven has fallen off materially in the past quarter century and this is thought to be partly due to the incompleted federal work about the port. Mr. Jackson made a vigorous plea for the continuance of the work. In the discussion a member stated that the lack of shipping facilities was not due to the shallowness of the channel but to the very small depth available in the slips, which were many feet shallower than the main channel. This channel could now carry at high tide any boat that would possibly be liable to enter the port, but the slips limited the ships to drafts of about 14 ft.

A CONCRETE WATER TOWER.—Mr. Edward E. Minor, New Haven, described the structural features of a reinforced-concrete water tower which has just been completed at Mill Rock, as part of the high pressure system of the city of New Haven. This tower, 50 ft. in diameter and 25 ft. in clear height, is on top of a ledge of rock some 250 ft. above the city datum, in so commanding a position that its top is used as an observatory. It is circular in plan with 18-in. plumb walls, reinforced circumferentially

with from 1¼ to 1½-in. round rods, carried 5 ins. c. to c. on vertical spacing angles 5 ft. on centers. The roof, a reinforced-concrete slab, in 16-ft. square panels, is carried on four concrete columns with connecting beams. Two sets of forms alternately placed one above the other were used, each set consisting of units 6 × 12 ft. in size. The mixture was a 1:2:4 trap rock concrete, and though no waterproofing mixture was used the walls show sign of leakage in but one patch of 3 ins. and that is of no consequence.

STREAM FLOW DATA.—Mr. Charles E. Chandler, Norwich, read a paper on "Stream Flow Data" which contained practically the same material as that presented by him in a similar paper before the New England Water-Works Association in November, 1907. Mr. Chandler has taken the available water flow data of several New England and New York streams and tabulated them in a form convenient for water-power use. He has done this to show other engineers the value of such tabulation in the hope that similar tables will be prepared for all streams on which long time records are available.

MASSACHUSETTS-CONNECTICUT BOUNDARY.—Ever since 1642, when the first surveys for the boundary between Massachusetts and Connecticut were made, and made with most unaccountable errors, there has been a running dispute between the two states as to the exact location of the line. This dispute even went so far as to involve the shifting of several towns from one state to the other as the tax rates rose or fell in the adjoining commonwealths. Finally in 1906 the latest of many joint commissions instituted a new survey, of which Mr. Henry P. Buck was the chief engineer for Connecticut. Mr. Buck read a paper before the present meeting, giving an historical account of the previous troubles and a description of the work of the last commission in running the line, establishing permanent monuments and filing records.

HYDRAULIC FILL DAMS.—Mr. Walter S. Morton, Hartford, delivered a paper in which he detailed the advantages of the hydraulic fill method of constructing earth dams, together with a description of some of the more recent constructions of this sort. With an ample water supply and a borrow pit near enough and of sufficient elevation, he considered this by far the most economical and scientific manner of building earth dams. The cost ought not to get higher than 15 cts. per cu. yd., about one-quarter of that usually figured for the ordinary fill and puddle method, and in some cases it has been brought as low as 5 cts. per cu. yd.

REINFORCED-CONCRETE BRIDGES.—Mr. M. W. Denman, Springfield, Mass., in a paper accompanied by views of bridges already constructed, outlined the advantages of reinforced concrete for bridges. Mr. Denman emphasized the necessity for trained men both in design and construction, for care in construction and inspection, and for the avoidance of an extra amount of steel just to take unknown strains. On this latter point he advocated putting enough steel to take the expected and computable strains, leaving the unknown to the concrete.

OFFICERS.

The following officers were elected for the ensuing year: President, Mr. Edward W. Bush, Hartford; 1st Vice-Pres., Mr. Frederick J. Easterbrook, New Haven; 2d Vice-Pres., Mr. Frederick H. Oldershaw, New Britain; Secretary and Treasurer, Mr. J. Frederick Jackson, New Haven.

RECENT IMPROVEMENTS IN FILE TESTING: AN AUTOMATIC TESTING AND INDICATING MACHINE.

A machine for testing files and indicating, by a selfdrawn diagram, their quality, condition, rate of cutting, etc., was brought out in England in 1905. When it was placed under trial, sample files were procured from the principal English and American makers, and tests were made which revealed extraordinary differences in quality—some files being worn out after filing away less than 1 cu. in. of iron, and cutting at the rate of 1 cu. in. per 10,000 strokes; while the best file tested removed 12½ cu. ins. of metal, and cut at the rate of 5 cu. ins. per 10,000 strokes.

The publication of the results aroused great interest among British file manufacturers. A public file-testing department was established; and several file manufacturers installed testing machines at their plants, conducting experiments to determine the most efficient form of file tooth and the most suitable grade of steel.

The result of this activity was that files were produced which showed an efficiency not previously attained. Fig. 1 is a reproduction of several diagrams traced by the machine, in which the ordinates represent cubic inches of metal removed and the abscissae the number of strokes made. Curve B in this diagram was registered for one of these files, which removed nearly 46 cu. ins. of iron and made 160,000 strokes before ceasing to cut.

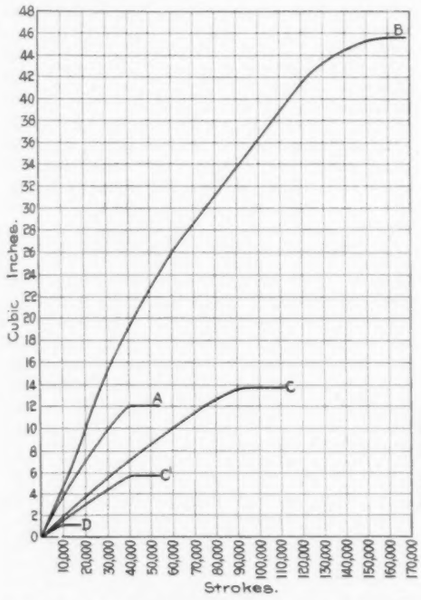

Fig. 1. Curves Traced for Four Files by Automatic File-Testing Machine.

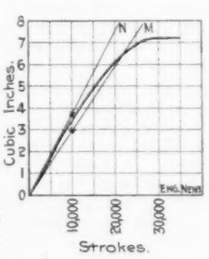

Fig. 2. Method of Computing Cutting Rate of a File, from Curve Drawn by Machine.

The makers of the machine state that still better results have been produced more recently, files now being made which cut iron at the rate of 8 cu. ins. per 10,000 strokes; and one file is on record by one side alone of which 55 cu. ins. of iron were removed. These results are traceable to the introduction of the automatic testing machine.

The machine, a photograph of which is shown in Fig. 3, will take files of any length from 4 ins. to 16 ins., means being provided for varying the length of the stroke. Bearing against the back of the reciprocating file is one end of a test bar, supported on rollers and forced against the file by means of a weight and chain. During the back stroke the bar is withdrawn.

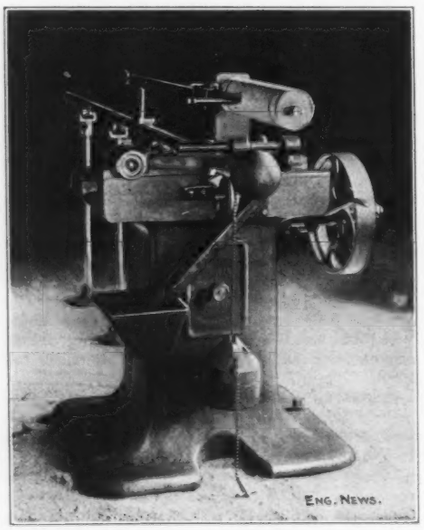

Fig. 3. General View of Automatic File-Testing Machine.

The diagram is made on a sheet of cross-section paper carried on the drum at the top. The drum is geared so as to revolve slightly with each stroke of the file, and the pencil is carried across the sheet by the cord connecting with the test bar.

Fig. 1 is a reproduction, to a reduced scale, of curves actually drawn by the machine for four bastard files made by well-known manufacturers. The cut of the file under test is taken from a standard test bar of annealed cast iron, planed to a cross-section of 1 in. × 1 in.; the ordinates, therefore, read directly in cubic inches of iron removed; and, as we have said, abscissae represent the number of strokes made. The rate of cutting at any period of the test is given by the slope of the corresponding part of the curve.

Curve A was recorded by "a file of good average quality as usually supplied by the best makers." It had a high rate of cutting, but was soon worn out—showing sharp teeth but poor steel. Curve B we have already mentioned, and it speaks for itself. Curves C and C' were made by the two sides of the same file; they show fair durability, but the slow cutting rates indicate poorly-formed teeth. Curve D distinctly brands the file by which it was traced; file B cut 5 times as fast when new, lasted 16 times as long, and did 46 times as much work.

Fig. 2 shows the method of determining the cutting rate of a file. The tangent N indicates the "nominal rate," or the sharpness of the file when new; and, since it cuts the 10,000-stroke line at 3.8, the nominal rate is 3.8 cu. ins. per 10,000 strokes. The line M, drawn to approximate the general slope of the curve, indicates the mean rate of cutting, which in this case is 3.0 cu. ins. per 10,000 strokes.

The machine is manufactured by Edward G. Herbert, Ltd., of Manchester,* England. We are indebted to the manufacturer for the information, curves and photograph.

To facilitate comparison of different files, Mr. Herbert has worked out a formula for finding at once the total cost of filing in dollars per 100 cu. ins. of metal filed away. The formula and its derivation is given below.

Let P = net price of a file of average size in dollars.

l = total cu. ins. filed by both sides of file.

W = rate of wages and establishment charges in dollars per hour.

C = cost in files, wages and establishment charges of filing 100 cu. ins. of metal.

R = rate of cutting in cu. ins. per 10,000 strokes (3,000 strokes per hour).

T = hours per 100 cu. ins. filed away.

Then cost of files per cu. in. filed $= \frac{P}{l}$.

Cost of files per 100 cu. ins. filed $= \frac{100\,P}{l}$.

Hours per cu. in. filed $= \frac{10{,}000}{3{,}000\,R}$.

$$T = \frac{333}{R}.$$

$$C = \frac{100\,P}{l} \times W \times T = \frac{33{,}300\,P\,W}{l\,R}.$$

*Rosamond St., East.

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Senator Knox, of Pennsylvania, in an address before the Pittsburg Chamber of Commerce on Feb. 12, took advanced ground in favor of radical extension by the Government of its work of waterway improvement. Taking as his text the work by the Government at Panama, he urged that in order to reap full benefit from the canal work, it is necessary to deepen all our ports to the same depth as the canal. We quote as follows:

We are expending a vast sum of money to dig the Panama Canal to a depth of 35 ft. That depth is fixed by the well-established fact that the cheapest ocean transportation is in the great vessels of about that draft. In order that the canal may give the commerce between the Atlantic and Pacific oceans its full development, this depth is admittedly necessary. But at the same time only two or three ports of the United States have a depth of water equal to that fixed for the Isthmian canal; and applications of cities to have their harbor channels deepened to that standard are met with procrastination if not refusal. If this is not amended, Congress will stand self-convicted of spending the nation's money in digging a canal and confining its fullest benefits to the commerce of other nations, or at best giving to the United States the privilege of using the full depth only through a few ports already notoriously congested.

Beyond the larger importance of cheap water transportation for general commerce and industry, the immediate requisite of securing a full return from the great investment on the Isthmus, and indeed the need of giving that canal its full traffic and revenue, establishes as basic in our national policy of internal improvements these propositions:

First:—That we should discard further procrastinations and set about the systematic and comprehensive improvement of all ports and waterways that are or can be made tributary to the canal, in order, if possible, to complete all of them with the completion of the canal; and if that is not possible, to complete the largest proportion possible.

Second:—That the maximum depth of the canal should be fixed as the minimum depth of the channels of every sea coast harbor of commercial magnitude or capable of commercial magnitude.

Third:—That all the rivers of the Mississippi basin should be improved to the highest standard of economic utility permitted by their physical and commercial character, and that the lake region should be given access through them to the Isthmian canal and the Pacific by modern and adequate canals, joining Lake Michigan to the Upper Mississippi and Lake Erie to the Upper Ohio.

We are in full sympathy with the idea that large and liberal expenditures for waterway improvements should be undertaken; but it seems proper to point out that the necessity for immediate action in deepening *all* our seacoast harbors is not quite so urgent as Senator Knox seems to think.

In the first place, the Panama Canal is being excavated to a depth of 40 ft. and not 35 ft., and this depth is given to it in view of possible needs a generation or more hence and not because of present requirements. If the nation were actually to adopt the policy of making all our seacoast harbors "capable of commercial magnitude" as deep as the maximum depth of the Panama Canal, the expense would run into many more millions than the Senator imagines.

By all means let harbor deepening and improvement go on wherever proportionate benefit to commerce can be shown; but there is no need of wasting millions in digging mud out of tidal rivers and ocean bars unless the deep channels will be used before fresh mud fills them up.

It appears to be a common idea that American seaports are behind those of other nations in capacity for large vessels, but actually we are in advance. In South America, Africa and Asia only a bare beginning has been made in the deepening of harbor channels. Even in Europe there are very few ports where large steamers do not have to await favorable tides to pass over the bar.

It is true that during the past half dozen years there have been built a few monster vessels, not more than a dozen or so all told, with a draft of over 30 ft. Most of these vessels are built to secure record-breaking speed for the trans-atlantic passage. With only two exceptions, all of them ply from the port of New York to a deep water port in Europe.

It is impossible to secure economic transportation with vessels of huge size and great draft except at the greatest ports, where a vast amount of traffic is handled, so that full and regular cargoes may be assured. Even here, except for the passenger traffic, it is extremely doubtful whether the biggest vessels, say of 20,000 to 30,000 tons, are actually as economical as vessels of 10,000 to 15,000 tons.

The fact is that when the Panama Canal is opened, vessels passing through it to Asiatic ports and the west coast of South America, are not likely to have more than 20 to 25 ft. draft at most, since with greater draft they would have trouble in entering the harbors there. Larger vessels may perhaps be used in the traffic to San Francisco and Puget Sound ports, where greater depth is available; but it is difficult to believe that more than 30-ft. draft will be required for anything more than a trifling part of the traffic for many years.

The question of harbor improvement, therefore, is practically little affected by the Panama Canal. Undoubtedly the work of harbor improvement will go on and ought to go on; but our present harbors are fully sufficient to permit us to take full advantage of the Panama route when opened.

With Senator Knox's platform of liberal appropriations for internal waterway improvement, we are in full sympathy. We confess our regret, however, that in his plea for canals "joining Lake Michigan to the upper Mississippi and Lake Erie to the upper Ohio" he overlooked the far greater need for giving the Lake region access to the Atlantic seaboard by a waterway of dimensions which would be impossible on the routes he has named.

In the area west of the Mississippi River the Federal Government has established 135 forest reservations with a combined area of over 122 million acres. East of the Mississippi there are no forests owned by the Federal Government and the only state forests are those owned by the State of New York in the Adirondack and Catskill Mountain regions. The urgent necessity of preserving from destruction the forests in the eastern Appalachians, particularly in the southern states and in the White Mountains, has been apparent to many for fully a score of years. Nearly a dozen years ago active agitation began looking to the creation of Federal forest preserves in these two sections; but action has been delayed year after year, and during this delay the value of timber lands has been rapidly mounting until to-day it is practically impossible to create the great continuous Federal forest reservations in these mountain regions that might have been made at moderate expense a dozen years ago.

In the West it was easy to create forest reservations, for the land was already owned by the Government. In the East all the land is in the hands of private owners, and its acquirement must be either by purchase or condemnation.

The agricultural appropriation bill a year ago, made provision for a careful survey of this region and investigation to determine what action the Government should take. The results of this survey have just been transmitted to Congress by Secretary Wilson and ought to command public attention and secure prompt action by Congress. The preservation of the forest cover on these mountain slopes is demanded not alone to preserve the timber resources from utter exhaustion. That is, perhaps, the least important consideration. The protection of the streams which flow from these mountains is assuredly of equal importance. The removal of the forest cover causes the streams to dry up in seasons of drought and to become subject to quick floods at every rainfall, thus affecting the water power at every fall in their course. Still worse, however, is the erosion which takes place on the steep mountain slopes, particularly in the Southern Appalachians when the forest cover is removed. In 1896 the late Prof. N. S. Shaler stated that from 3,000 sq. miles of land in these mountains the removal of the forest had been followed by the erosion of the soil; the mountain side has become a barren desert, seamed with gullies from which every storm brings down vast quantities of earth. This chokes the channels of the streams in the valleys below and spreads over and ruins thousands of acres of fertile lands along their course.

These mountain slopes must have their forest cover protected and where it has been removed it must be restored, or else destruction will be wrought far more widespread than anyone can now foresee. The question is how this result may be brought about. The report before us indicates that cooperation of State and National governments and of private land owners will be essential. The price of virgin spruce lands has risen as high as $75 to $125 per acre in the White Mountains, and in view of the vast areas of which control must be acquired, the Government will have to confine itself for the most part to the purchase of cut-over lands. It may possibly, however, secure control of certain virgin lands under an arrangement whereby the ripe timber may be removed under Government direction in a manner which shall protect the forest cover and permit early reproduction of a new timber crop. The final recommendation is that 600,000 acres be acquired in the White Mountain region at a maximum average price of $6 per acre, and that 5,000,000 acres be purchased in the southern mountains at a maximum average price of $3.50 per acre.

Engineers appreciate better than any other class of the community, probably, the importance of forest preservation at the headwaters of our rivers for the protection of water power, water supply and navigation. Members of the profession able to exert influence with Congressmen to secure favorable action in this matter should not fail to do so.

At Harrisburg, Pa., the trial is now in progress of Sanderson, the contractor who supplied the new State Capitol building with chairs, sofas, and various other furnishings and received payment therefor by the cubic foot, to a total amount of nearly six million dollars. In conducting the trial the prosecution presented evidence to show that in the years previous to the

time when the carnival of graft began, Sanderson had supplied other furniture to the State and received payment on sofas, for example, at a price per linear foot of length. The attorneys for the defense, on the other hand, in opening their case on Feb. 12, declared that Sanderson had the right to charge for the goods which he delivered by the square foot of surface. His contract price on certain "trimmings," for example, was "$18.40 per ft." As cubic or linear measure would not fit all the articles, Sanderson's attorneys maintained that he had the legal right to charge for the goods by the square foot of surface; and that it was really magnanimous sacrifice on his part to relinquish this right and accept payment for certain articles on a cubic foot basis.

It seems to us that the absurdity which led to and made possible the commission of the frauds was the letting of a contract for such articles as chairs and sofas and tables and chandeliers on any sort of "per foot" basis.

As well might one buy oil paintings by the square foot or marble statuary by the pound. What private individual or private business corporation would let a contract for high class mahogany furniture on prices bid per foot—be the foot measured in any manner whatever?

Engineers understand—even if architects do not—that the only reasonable way to let a contract is to make specifications for a certain definite article or piece of work, so well defined that bidders may know certainly what is required, and bid upon a uniform basis. If the task cannot be thus defined, then it should be done by day's work, instead of by contract. Or if the work is of a sort which cannot be thus performed, like this furnishings contract, then the basis of actual cost plus a percentage or a fixed sum appears to be the only feasible method if a contract is to be made in advance and the goods are not purchased outright.

THE LABOR UNIONS' PART IN PRODUCING HARD TIMES.

In discussing some weeks ago* the financial depression of 1907, we showed that the most important underlying cause was that the savings available for investment were insufficient to supply the demand. To a large extent the same conditions still exist. While considerable amounts of bonds have been disposed of to investors during the past six weeks, the demand for investment capital still remains far in advance of the supply.

It is this relation between the supply of capital and the demand that is responsible for the low price of stocks and bonds. It is this that compels railway companies to postpone work on extensions, double-tracking, enlarged terminals and other improvements. It is this that delays municipal improvements, buildings, water power plants and various other enterprises on which engineers are engaged.

We showed in the issue above referred to how the capital available for new enterprises comes wholly from the savings of the people, and explained what a part the extravagant living of the past few years had played in cutting down the amount available for investment. This extravagance, as we said, has been on the part of the poor as well as the rich. In the flush times of the past seven years, the tendency to live up to and beyond one's income has been as common among wage workers as among millionaires.

It is not generally realized, we believe, what a large part the labor unions have played in reducing the fund of investment capital and thus bringing about that very financial stress from which so many laborers are now suffering. With much that the labor unions have done, most broad-minded men are in full sympathy. The labor union appears to be a necessity to enable the man who sells his labor to meet the employer—the man who buys labor—on something like equal terms. Many will be found to defend what the labor unions have done in reducing working hours and increasing wages. When, however, it comes to reducing the efficiency of labor by placing the drone, the drunkard and the shirk on the same level with the sober, steady and industrious worker, it is hard to find any sort of defence.

From all quarters we hear the report that the worst feature of the labor market of 1906 and 1907 was not the high prices and the short hours, but the absolute inefficiency of the workers. What that means as a contributing influence toward the production of hard times is easy to see. That extravagance has been a chief cause in producing the present financial situation is agreed by all; but in economics no hard and fast line can be drawn between extravagance for luxuries and proper expenditure for necessities. We can say simply that the more money a man earns and the less he spends, the more he will have available to invest. What is true of one man is true of ten men, twenty, a thousand, a million.

It may be said that if all men saved and no one spent, there would be a plethora of funds and no demand for them; but taking the world as it is, that condition never exists. What we call "over production" and "lack of demand" is really lack of ability to purchase. Human nature is such that people as a whole always want more than they possess.

When carefully analyzed, it is seen that inefficiency of labor can be regarded as a luxury just as much as expenditure for furs or automobiles. The community or the nation has about so much human energy to utilize during the year. If the community or the nation is extravagant, everybody's time may be occupied in supplying daily wants, real or fancied, and there will be no time left for permanent improvements—engineering works, let us say. But this extravagance may take the form of loafing while pretending to work, and the same effect will be produced. If the workers of a community idle away their time, they cannot build the sidewalk or the roadway or the irrigation ditch which they might have had time to build had they worked industriously.

The same conclusion is reached if we take another point of view. A railway or a manufactory makes profits from a year's business which are closely dependent on the industry and effectiveness of the labor in its employ. High wages may reduce dividends to the owners, and yet give more money to the workmen to put in a savings bank. But moderate wages coupled with inefficient work will just as certainly reduce the owners' dividends, and the workers are likely to have little or nothing to save to add to the investment fund.

It used to be the motto of one prominent labor organization that the injury of one was the concern of all. We may reverse that motto and say that the mischief done by a few—the inefficiency and waste of human effort which so many labor unions have fostered—has wrought an injury to millions of industrious workers who had no part in the campaign of idleness that has wrought so disastrously to our national welfare.

On the same plane with inefficient work must be placed opposition to labor-saving machinery, restrictions to prevent effective use of workmen, opposition to apprentices, which causes men to be idle who ought to be usefully employed. All these cause an increase in the cost of labor, reduce the output available for a given expenditure, cut down the earnings available for dividends.

Perhaps some labor leader may object that he does not want the men of his union to work industriously for the sake of earning dividends for some wealthy man. But if railways and factories and mines do not earn dividends, there is no incentive for anyone to invest capital in them, even when it is available. A million men are idle to-day who would be at work if money could be secured to build new railways, buildings, bridges and other works; and funds for not a few of these have been shut off because of reduced earnings, which are due in no small part to the inefficiency of labor.

Have the labor unions learned a lesson from the experiences of the past few months? If they have not, then the individual workers have, in not a few cases at least, for we hear on all hands that with the weeding out of forces that has taken place since slack times began, the workers that remain are exerting themselves to hold their places.

There is no more important problem before engineers and executive heads of our great industrial enterprises than the problem how to secure continuously efficient labor. To secure a maximum quantity and superior quality of output with the least expenditure of labor, and at the same time to so reward the worker that he can live decently and have a constant incentive for improvement—that is the task which presses harder for solution to-day than at any previous time.

*Engineering News, Jan. 2, 1908.

LETTERS TO THE EDITOR.

Driven Wells in the Bed of the Ohio River as a Source of Water Supply.

Sir: As a resident of one of the cities drawing its water supply from the Ohio River, I am very much interested in the system of supply adopted at several places and proposed at several others on this stream. This system depends on supplying water from well points driven in the river. These wells are probably 15 to 30 ft. deep and are driven into a suitable sand and gravel bed, the claim being that in this way a natural sand filter takes the place of the artificial one generally deemed necessary. The system is much cheaper than an artificially constructed one both as to first cost and as to maintenance, and the results obtained from analysis of the water are wonderful, practically 99.9% of the bacteria being removed.

If really efficient, the knowledge of this system would be a boon to many a town and city; if not, its demerits should be made known at once.

I would be glad if any of your readers can give me any information on this subject.

Very respectfully,

F. C. B.

[Driven wells, whether sunk in river beds, lake beds or elsewhere, are a well-known source of water supply. As a general rule, it is safest to consider wells in river or lake beds as wells, rather than as filters. It is also to be noted that such wells are generally of a comparatively limited capacity, and that they often have a very disappointing way of decreasing in yield after being in use a few years.—Ed.]

The Aims of the Hydro-Electric Commissions of Ontario.

Sir: I notice in your issue of Dec. 19, a digest of the reports of the Hydro-Electric Power Commission of Ontario and having been chief engineer of the first commission of investigation from the date of its inception, July, 1905, until its dissolution, May, 1907, I desire to call the attention of your readers to that part of the reports on which you have said practically nothing.

The aims of the Commission were three-fold:

(1) To examine into and report upon the hydraulic possibilities of the province from an electrical point of view.

(2) To describe the hydro-electric constructions already built or under way.

(3) To determine the industrial needs of the various towns and cities of the province, as regards a supply of electrical power, and to work out, in detail, transmission and generating schemes to meet these determined requirements. The hydraulic investigations were carried out as completely as time and expense would warrant and consisted briefly in a canoe traverse of every river, a measurement of the height of each important fall or rapid, and a careful survey of the site of each important power location likely to be in demand within the near future. Various maps were taken for a determination of the extent of each drainage area, but the more important rivers were gaged for height daily for a year and the discharges measured quite frequently.

The tabulated results are of considerable permanent value for reference and are eagerly sought for by parties interested in developing the natural resources of any particular district.

The various generating and distributing schemes as worked out are tentative only and indicate reasonable methods of satisfying present industrial demands. The commission, I believe, fully appreciated the fact that there are many alternative schemes available and that local and financial considerations may make other solutions more desirable. Lastly, by bringing home to the minds of the people the enormous possibilities of hydro-electric development the Commission aimed to encourage investment in these attractive and permanent sources of power in a province unfortunately not blessed by nature with any coal deposits of commercial value.

As soon as this first Commission had presented its first report, on the Niagara District, because of the very widespread representations made by municipalities, the Government decided to appoint a permanent Commission

under a provincial act of parliament. This Commission was composed of the Hon Adam Beck, Hon. J. S. Hendrie (members of the Provincial Government), and the writer. It then became necessary to appoint a chief engineer, and Mr. P. W. Sothman received the appointment. In May, 1907, owing to business engagements, it became necessary for me to resign my position as a member of this second Commission, and my position was taken by Mr. W. K. McNaught, M. P. P. This Commission is very active at present, and as some fifteen cities and towns have voted by-laws in favor of purchasing power through the Government Commission, and as also in January of this year voted money for local systems to distribute the government power throughout the municipalities, it would appear that the whole proposition is likely to become effective, and we will hope, successful. Yours very truly,

Cecil B. Smith.

Smith, Kerry & Chace, 124-126 Confederation Life Bldg., Toronto, Canada. Jan. 28, 1908.

[In the short space that we were able to give to the digest of these reports we endeavored to present the estimate on the cost of pioneer hydro-electric development, with only brief mention of the aims of the Commission at the beginning of the article. This abbreviated statement, however, covers the three aims emphasized by Mr. Smith.—Ed.]

THE WASHINGTON, BALTIMORE & ANNAPOLIS SINGLE-PHASE ELECTRIC RAILWAY.

The first single-phase electric railway to be seriously considered in this country was for the line between Washington, D. C., Annapolis, Md., and Baltimore, Md. In the fall of 1902 the first public notice of such a project was made, and about that time a paper was read before the American Institute of Electrical Engineers describing the alternating current motor which was to be used, and entering somewhat into the details of the construction of the road. (Eng. News, Sept. 11, 1902, p. 182; Oct. 2, 1902, p. 268). Owing to financial difficulties this scheme, of which the Westinghouse Electric & Manufacturing Co. were the engineers, was abandoned and the honor of the first alternating current railway in the United States fell to some other road. In 1905, however, entirely different financial interests concerned themselves with an interurban route connecting the three cities, and under a different engineering design, but still with single-phase equipment, set out to build the road, the greater portion of which is now complete. The line from Washington to Annapolis was opened on Feb. 7, 1908.

At first glance it would seem that long before this an electric interurban road would have been built along this route. Baltimore and Washington, of 550,000 and 305,000 population, respectively, are only 38 miles apart in an open, fairly level country free from any great amount of waterways which necessitate heavy bridges. Annapolis, the capital of the State of Maryland and the seat of the United States Naval Academy, is about 18 miles at right angles from the middle of a line between the two larger cities, and up to the present most difficult of access from either one. The social and business relations of the three cities are such that a rapid and sure electric service would seem to be a paying proposition. There is no doubt that in the Middle West a similar condition of affairs would have long ago brought about an interurban railway construction. But the conservative East has not been so anxious to adopt electric traction for heavy service.

Fig. 1 is a map of the road and the surrounding country. Washington and Baltimore have been connected since the earliest days of railroading by the two steam lines now shown as belonging to the Baltimore & Ohio Railroad and to the Pennsylvania Railroad. The new electric line, known as the Washington, Baltimore & Annapolis Electric R. R., consists of the following parts:

(1) A double-track standard-gage road, operating on single-phase alternating current, herein termed the main line, running from the city limits of Washington at 15th and H Sts., N. E., a distance of 37.6 mi., to a station in the business center of Baltimore. Of this 37.6 mi. of track, about 4 mi. is in the District of Columbia,

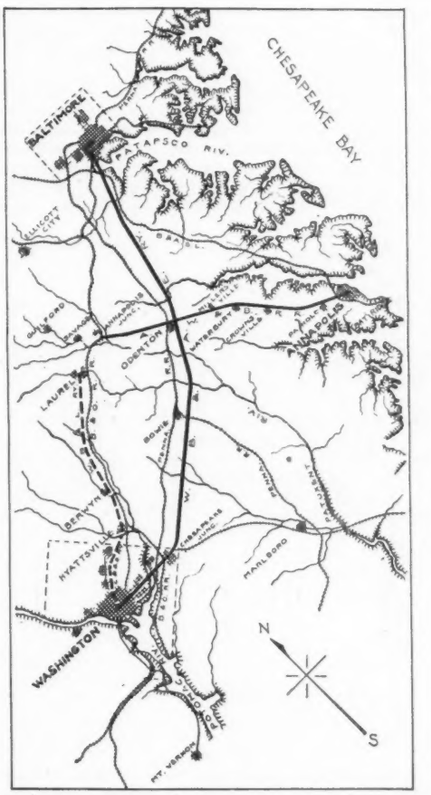


Fig. 1. Map of Washington, Baltimore & Annapolis Railway. (Single Phase 6,600 Volt Operation.)

operated jointly with local companies, and about 1½ mi. is in Baltimore, used jointly with the city railways there, with an extra rail to provide for a change in gage, which is 5 ft. 4½ in. in that city. The cars of the line will be carried directly to the station in Baltimore, but for the present the Washington terminus will be the city limits noted above, transfers being there granted to any of the local car lines.

(2) A single-track standard-gage road, located practically at right angles to the main line and crossing the latter about 15.5 mi. south of Baltimore. This line is the Annapolis, Washington & Baltimore R. R., originally one of the oldest steam railways in this country and now electrified and operating on the same current as the main line. It is 20.5 mi. long and connects with the main line of the W., B. & A. E. R. R. at Academy Junction, with the Pennsylvania R. R. at Odenton, and with the B. & O. R. R. at Annapolis Junction.

(3) A single-track standard-gage suburban line, termed the Berwyn & Laurel Electric Ry., running north from Washington between the towns of Berwyn and Laurel, and connecting at Berwyn with a branch of the Washington Ry. & Electric Co., continuing into Washington. This branch is operated on direct current and is entirely separate from the main line. Eventually it is expected that it will be continued to Annapolis Junction, there to connect with the single-track A., W. & B. R. R. to Annapolis.

The total mileage of single track thus consists of 67.28 mi. on the main line, 20.5 mi. on the A., W. & B. R. R., and 9 mi. on the Laurel branch. This is exclusive of connecting lines in the cities. At present the main line is in operation between Washington and Academy Junction, and the single-track line between the Junction and Annapolis. The remainder of the single-phase line is expected to be completed within the next few weeks. The direct current Berwyn and Laurel line has been working for some years.

As the country is still somewhat undeveloped along the main line a through service is expected to be its principal business for some years to come, leaving the Berwyn branch to take care of local and suburban traffic. The main line will operate on a 15-min. schedule, with a 60-min. rate between Washington and Baltimore and slightly longer from either city to Annapolis.

TRACK DETAILS.—The line throughout is constructed after the most approved methods for through, heavy traffic. The rails, of 80 lb. sections in 33 ft. lengths, are laid on 6 × 8 in. × 8 ft. 6 in. chestnut ties ballasted with gravel 12 ins. deep. The ballasted section is 23 ft. in width, with 11 ft. between centers of tracks. The main double track system is all new work, but the single track Academy Junction-Annapolis branch, while using the same right-of-way and roadbed as the old steam road, has entirely new ties and rails and some few new structures. Although there are no very deep cuts or fills, the country is so rolling that about 1,600,000 cu. yds. of excavation have been made. This is largely due to the effort to eliminate grade cross-

FIG. 2. VIEW ON THE ELECTRIC LINE BETWEEN WASHINGTON AND BALTIMORE.

ings and to keep down the grades. As a result there are only two grade crossings of any consequence along the entire road, and the maximum grade, aside from a 5.7% 500-ft. approach to a bridge inside the city limits of Baltimore, is 2%. As a further advantage, 79% of the line consists of tangents, with one curve of 8°, all others being below 1°. At one place on the line a 5-mi. tangent is connected to a 6-mi. tangent by a 1° curve. The view shown in Fig. 2 gives a good idea of the style of track construction. It is taken along the long tangent noted.

The bridges along the line are of steel where permanent, timber trestles being used in several

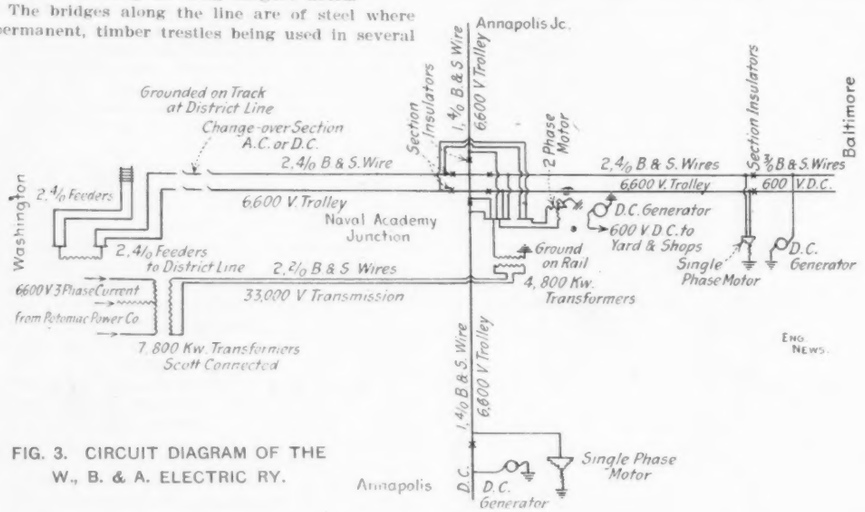


FIG. 3. CIRCUIT DIAGRAM OF THE W., B. & A. ELECTRIC RY.

places where changes are expected. Immediately after leaving the city limits of Baltimore the road crosses a series of truss bridges, plate girders, timber trestles and fills aggregating nearly a mile and a half in length. There are two short tunnels built in open cut of reinforced concrete, with vertical walls and horizontal slab roof. One of these tunnels is 88 ft. in length, the other 270 ft., and they are connected by 103 ft. of retaining walls on either side of the track.

Considerable difficulty was experienced where the line crosses the Patapsco River. At this place the Baltimore & Annapolis Short Line, which is being equipped with a Westinghouse single-phase system, runs on a trestle fill about 60 ft. away from and parallel to the main line of the W., B. & A. E. R. R., and when it was attempted to fill from a trestle on the latter the entire surrounding country rose. A bridge on concrete abutments at the end of the trestle sunk out of sight, and the engineer had only time to save the plate girders from the disappearing abutments. Guy wires were tied between the parallel trestles in the effort to hold them in line, but the cables were snapped by the strain. Finally, the bottom of the hole was reached by the fill and a stable embankment has been p'aced.

ELECTRICAL OPERATION.—The transmission of the electrical current and the operation of the machinery has been carried out practically as originally designed. This design was described in our issue of Oct. 18, 1906, p. 401. The circuit diagram is reproduced in Figs. 3-4. As has been noted, the cars are operated on alternating current at 6,600 volts, and in single phase with a frequency of 25 cycles per sec. Power is purchased at Benning, D. C., near the District line, from the Potomac Electric Power Co., and delivered to the Washington substation at 6,600 volts, three-phase. At this substation seven 800-KW. transformers, Scott or T-connected, reduce the three-phase current to two-phase, one-half of the secondaries being wound for 6,600 volts and the other half for 33,000 volts. The 6,600 volt windings are connected in parallel on the same phase, and supply the trolley current up to the Academy Junction substation. The 33,000-volt secondary windings are connected in multiple on the second phase to a 33,000-volt transmission line which carries current to the Academy Junction substation, there to be reduced by four 800-kw. transformers to 6,600 volts, single-phase, which is used to operate the lines between the junction and Baltimore and Annapolis, respectively.

At Academy Junction, in addition to the substation, extensive yards and shops are located. These yards and the machinery in the shops are all to be controlled by direct current in order to reduce the element of danger from high-tension wires to a minimum. There are therefore installed in the substation two 300-kw. motor generator sets, operating in two-phase, one of which comes direct from the trolley circuit between Washington and the Junction, and the other from the transformers in the substation. After the motors of these sets have been started in two-phase they can be changed over the single-phase. These motor-generators take the 6,600 volt a. c. and deliver a 600 volts d. c. to the yards and shops. As all three cities require low tension trolley circuits in their limits each substation at the three cities has two 300-kw. motor generator sets reducing to 660 volts d. c. The current is carried to these substations along the 6,600-volt trolley and rail return circuit.

ROLLING STOCK.—The motor rolling stock consists of 19 cars for through traffic equipped with four 125-HP. motors, and four cars for local traffic, the same as the other 19 except that they have only two motors. There are also two locomotives for hauling freight cars which are also equipped with four motors, but which are geared much lower than the through cars. The cars, one of which is shown in Fig. 6, are remarkably large and imposing. Their main dimensions are as follows:

Length over buffers	62 ft.	2⅝ in.
Length over vestibules	60 ft.	7¾ in.
Length over car body	51 ft.	1¾ in.
Length smoking compartment	12 ft.	7⅝ in.
Length passenger compartment	38 ft.	6⅛ in.
Length of vestibules	5 ft.	0 in.
Width over sheathing	8 ft.	10¼ in.
Width over all	9 ft.	¾ in.
Height under sills to top of roof	9 ft.	6 in.
Height track to top of roof	13 ft.	½ in.
Between bolster centers	37 ft.	5 in.
Weight car body	40,000 lbs.	
Weight trucks	29,800 lbs.	
Weight electric equipment	37,200 lbs.	
Weight air brakes	2,000 lbs.	
Weight on track	109,000 lbs.	
Speed per hour	75 miles	
Seating capacity	66 persons	

The main underbody is of steel, with a wood upper works. The trucks, wheels and axles are standard steam railway sizes and shapes. Westinghouse automatic air brakes and signals are provided, in addition to hand brakes. The cars are electrically heated and lighted with side drop shaded incandescent globes. They are made by the Niles Car & Manufacturing Co.

The motors are of the series repulsion type, General Electric A-603, 125-HP. each, and are capable of being run under either direct or alternating current. When the cars are running in the city under direct current the four motors are connected in series and are controlled by the usual rheostatic resistance. Under alternating current the motors are in two pairs, each pair being two motors in series. A trolley wheel connection is to be used at first on all cars, but a pantograph will be installed on the freight locomotives and will be gradually developed so that it can be used on all cars.

The line system is the single catenary type supported on side bracket trolley poles spaced every 150 ft. on tangents, with the hangers spaced 16 2-3 ft. c. to c. The details of the pole and hanger are shown in Fig. 5 and in the view in Fig. 2. The poles are creosoted wooden sticks set 6 ft. 6 ins. in the ground, and 31 ft. 6 ins. high, carrying on the inside a braced T-iron bracket extending out over the track 11 ft. The poles are guyed in all directions, away from the track by a line fastened to a dead man, parallel to the track by the connecting wires and inside to the opposite pole across the track by wire cables, insulated in the middle, as shown in the half-tone, Fig. 2. On account of the high-tension current which is passing through the trolley wire, ample insulation is provided at all places where the current might pass to the ground. The insulator which carries the messenger wire over the trolley bracket is of the well-known porcelain cupola-shaped type, and is provided with four horizontal cross cuts so arranged that in case the insulator gets hit the break will occur along one of these lines and will not damage its insulating properties. The hangers are very simple clutch bars (Fig. 5), and were very easily erected from a train of box cars, as much as 4 miles of trolley wire having been hung in one day.

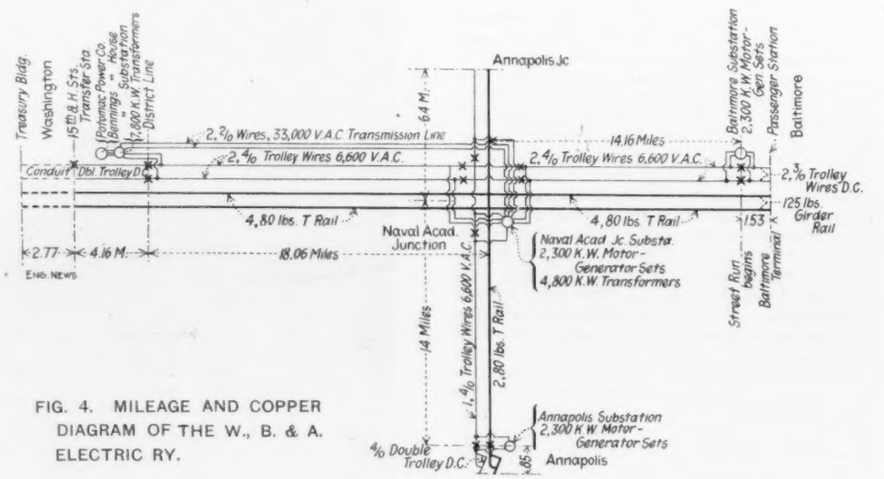
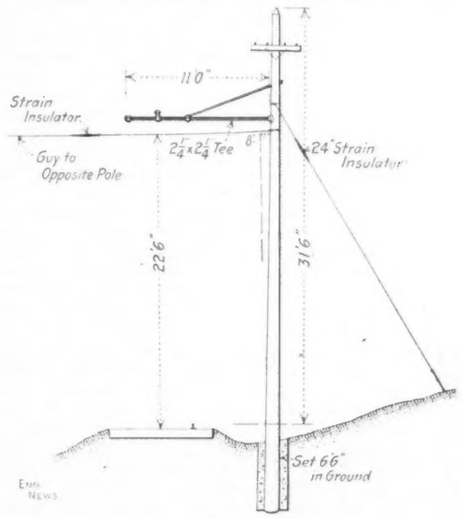


FIG. 4. MILEAGE AND COPPER DIAGRAM OF THE W., B. & A. ELECTRIC RY.

BUILDINGS.—The buildings of the company consist of a terminal station and offices at Baltimore, substations at Baltimore, Washington, Academy Junction and Annapolis, and a shop and yards at Academy Junction. The shops are in a reinforced-concrete building, 257 × 84 ft. in plan. The building is divided longitudinally in two parts, in one of which there is a girder crane traveling along the sides of the room on rails set in reinforced-concrete girders. In the repair room there is a cross track running perpendicular to the repair tracks, upon which is a small car which may remove trucks or motors from the cars under repair and transport them to the open where they can be more easily reached. As noted before, the entire shop and the open-air storage yards are under control of a 660-volt direct current.

OFFICERS.—The officers of the railway are Mr. George T. Bishop, President; Mr. John Sherwin, 1st Vice Pres.; Mr. J. N. Shannahan, 2d Vice Pres. and General Manager; Mr. C. F. Gladfelter, Treas., and Mr. W. A. Kappler, Secy. The engineering portion of the construction has been under the complete charge of the Roberts & Abbott Co., of Cleveland; the electrical equipment is by the General Electric Co., and the general contractor is the the Fidelity Construction Co., of Detroit. We are especially indebted to Mr. Shannahan, the General Manager of the road, and to Mr. Roberts, of the Roberts & Abbott Co., for the information herein presented.



Trolley Pole.

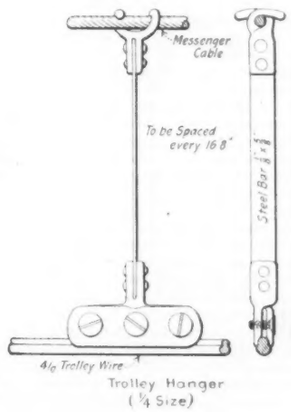


FIG. 5. TROLLEY POLE AND HANGER ON W., B. & A. ELECTRIC RY.

THE ENGINEER AS A MAN AMONG MEN.*

It is held in certain circles, I know, that the old-time culture studies—so called—have some magic influence in upbuilding character—producing men. It is tacitly assumed that your schools of engineering and chemistry and technology have no such high aim. It is a common argument that these schools of engineering and the industrial arts must be maintained in order to produce the trained men necessary for foremen and superintendents and managers.

All this is true enough, but is it the whole truth? Are the engineering colleges and the technical schools training students *solely* for the benefit of mills and factories and mines and railways? If this be so, then your engineering school stands on a level with the blast furnace and the cotton factory. It is just one wheel in the huge industrial machine. There is no more reason for adding the graces of architecture to the buildings that house it than there is for decorating a saw mill.

I stand here to make emphatic denial of such a doctrine. Our technical schools are not built merely to furnish brains for the operation of railways and factories. It is just as important that the graduates of our technical schools shall be men of character, fit for social, economic and political leadership, as it is that they be expert in their profession.

Our universities have won their well-deserved laurels not by training engineers, or chemists, or even scholars; not even by training preachers or teachers, doctors or lawyers; but by training—*men*.

Our university and all universities deserve honor and support—not because they are a necessary wheel in modern commerce and industry—not because of their instruction in science and letters—but because we look to them more than to any other institution to train the men on whom the future of the nation depends.

If time permitted I would discuss with you the claim, to which I have alluded, that the so-called liberal education of the past was better fitted to upbuild character—to nurture a high type of manhood—than the modern education in science and the arts. This I *can* tell you, that the leaders in engineering education are fully alive to the need that their institutions shall send out men as well as engineers. This I can tell you, too: That while no intelligent man can doubt the value of the so-called culture studies, they are being pursued by many youths today with no resultant effect.

You younger men may some day be more thankful than you are now that in the engineering schools the gospel of hard work has always obtained. If the rigid requirements of the engineering schools have driven the gilded youths to seek the easier courses of the arts department, that, I take it, is another reason why we may look for high standards of life and conduct among the engineers now coming on the stage.

Still again, say what you will of the engineering course or any other courses of study. I can testify from a wide acquaintance among engineers of the United States, extending over more than a score of years. I say to you that I know of no set of men who possess in greater degree the qualities of breadth of outlook, high sense of honor, fidelity to duty, and loyalty to principle, than the members of the engineering profession.

. . . . . .

The silent industrial revolution which the engineer has wrought with the results of modern invention has brought us face to face with a new set of problems. A new set of problems, and yet it is the same age-long battle of the masses against the classes.

Where shall our university and its sons be found in this battle? Certain institutions because of aristocratic traditions or the influence of wealthy benefactors may range themselves on the side of the barons; but who can doubt that the University of the Green Mountain State, with by far the greater number of our universities everywhere, will be found fighting under the banner of democracy?

I go back in memory more than twenty years, to the time when I was a student here. My room-mate was a New Yorker and greatly interested in the reports from the Legislature at Albany. A hot fight was being waged there that spring against long-intrenched forces of political corruption. The leader in that fight was a young Harvard graduate of whom we had never heard before and his name was Theodore Roosevelt. From that day to the present Theodore Roosevelt has been waging warfare against political corruption. He has fought the battle of the people against their spoilers. His high-minded devotion to the country's service has been an example and an inspiration to thousands and hundreds of thousands, ay, to the whole nation and to the world.

The despoilers of our national domain, the corrupters of our national life, the exploiters of the people—these have found a President of the United States big enough and brave enough to frustrate their plans and set the law in motion to punish their crimes. Is it strange that these men should exert their vast influence and power to cause the press and the bar and even the pulpit to hurl maledictions at his head?

But do you think that all the utterances thus inspired can shake the confidence and trust of the American people in their President? Listen and you shall hear from Maine to California the answer:

"We love him for the enemies he has made."

But your carping critic says, "What has President Roosevelt done?" I will tell you what he has done. He has awakened the American people to the dangers that beset them. A century ago our ancestors made untold sacrifices that to us might be preserved life, liberty and the pursuit of happiness. We today are struggling with conditions of life of which they never dreamed. A man may have political liberty, but his pursuit of happiness will be vain if he remains an economic slave. To preserve free opportunity as a heritage of the people; to make the square deal a reality for all sorts and conditions of men—that is the ideal which Theodore Roosevelt, as a great constructive statesman, has set before this nation. And the people will never give up this ideal until they make it a reality.

Do not think that in saying these things I am preaching a doctrine of radicalism. I am aware that many very good and very timid people are afraid to accept President Roosevelt's platform that the Government must control the corporations. But they are blind, stone blind, who do not see that if the Government does not control the corporations, the corporations will control the Government. Indeed, it is common knowledge that many of our city and state governments already are and long have been directed by corporations.

I cannot impress it on you too strongly that the President's policy is actually the policy of true conservatism. We stand at the parting of the ways. Down one path are our fatuous financiers demanding that the Government shall keep its hands off and let them work their will. Down another path lie the fast growing hosts of anarchy, of socialism, of enmity to all law and order, armed with many a just grievance against conditions of the past. If we would escape the destruction that lies down either course we must accept the principles which the President has so ably advocated, and create a government which shall truly be "of the people, by the people and for the people."

And is the engineer a mere passive looker on in this

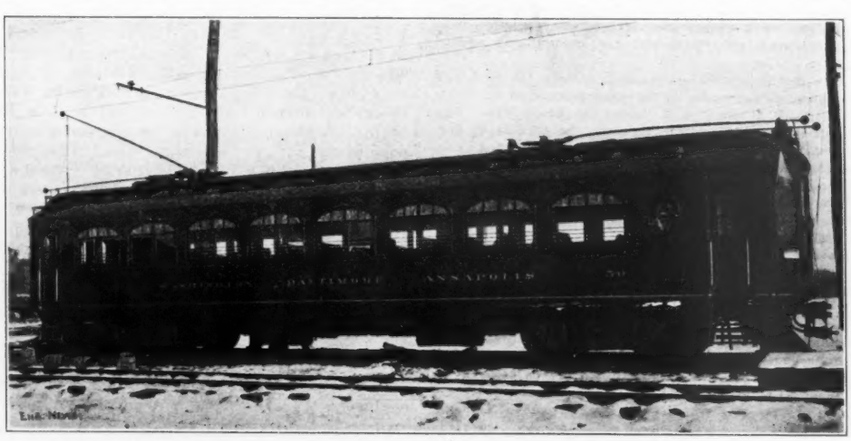


FIG. 6. HEAVY INTERURBAN ELECTRIC CAR IN USE BETWEEN WASHINGTON AND BALTIMORE.

*Extracts from an address by Charles Whiting Baker, Editor of Engineering News, at the annual dinner of the engineering graduates and students of the University of Vermont, Feb. 10, 1908.

struggle to establish anew our liberties? In the fight for good government and honest politics in city and state and nation, is the engineer nothing but a cog in the industrial machine?

I know engineers all over this broad land. I know how the engineers at Washington have stayed up the hands of the President in his battle against the despoilers of the nation. I know how engineers in New York City are guarding the public franchises, administering with fidelity great public works, standing like a rock against the giant forces of corruption. And these are only typical examples.

Is there need that the engineer of today should be a *man*—a man of sturdy moral fiber, a man of judicial temper, a man absolutely incorruptible? If you doubt it, take the other alternative. Suppose the engineering profession should lose its honorable position. Suppose engineers throw their manhood to the winds, accept bribes, betray their trusts. Suppose your army engineers are all Oberlin Carters, suppose your civilian engineers are all grafters. Where then would be your public works? How then could you by any possibility have good government in city or state or nation?

The people must trust some one. Experts must conduct our public business or colossal waste and destruction will be wrought through sheer ignorance. We must have experts—engineers—who can be trusted, who are incorruptible. This demand comes not alone from the cities and the states and the nation, it comes from the corporations great and small. The men at the top may indulge in high finance but they want their engineer to be faithful to his trust.

I am not content to emphasize fidelity alone. Your engineer is more than a faithful slave, or a faithful overseer. There is laid on him more and more the responsibility of leadership. In the community where he lives, in the states, in the national government, engineers are coming to the front more and more as safe and sane leaders. I can show you to-day communities, created by the engineer, where he is the main influence, upholding law and order, planting the school, rearing the church, surrounding the community with all the things that make life worth the living.

No one doubts that the race for riches will go on. Indeed it is a proper spur to urge men forward to do the best that in them lies. And yet I am sure that as we grow older other things in life bulk far larger. The engineer may gain wealth—not a few do; but in any event he has the chance to win far better things.

I need not remind you of Tredgold's majestic definition of the engineer's work—to harness the great powers of nature in the service of man. And what a wondrous progress has been made in that work since Tredgold's day. To what a marvellous extent have steam and water and electricity been tamed and compelled to labor for the comfort and happiness of the race.

But the engineer's field of work has broadened even beyond Tredgold's definition. It is under the guidance of his hand and brain that the mines of the earth yield up their hidden treasures. He has laid down a world-wide network of iron pathways by which the products of industry are distributed to earth's remotest corner. By his work of sanitation he battles with disease and death, saves lives by the thousand and ten thousand, and transforms the abodes of pestilence into places of safe habitation.

The engineer is the great civilizer. It is his web of wires and rails and steamship routes that has bound the nations together and is fast making the human race one homogeneous whole.

Surely, it is a high privilege to have a part in the performance of tasks like these. Even if he win not wealth in the task, the engineer may win honor, preferment, the consciousness of momentous duties well done; the respect, esteem and confidence of his fellow men; the love and devotion of a circle of associates and friends. If he wins laurels like these, then indeed, fortune has bestowed on him her choicest gifts.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF PLUMBING INSPECTORS AND SANITARY ENGINEERS.

The third annual meeting of this society was held at Chicago on Feb. 10, 11 and 12, with a good attendance and a good program.

At the first session the President, Mr. Henry B. Davis (Washington, D. C.) reviewed some of the technical developments of the year and the work of the society. Many states are now passing laws to prevent sewage pollution of rivers, and when this system of disposal is prohibited the sanitary engineer must be called upon to offer a solution of the problem.

DRINKING WATER FOR LARGE BUILDINGS.—This paper, by Mr. Thomas N. Thomson (Scranton, Pa.) dealt with the necessity of sterilizing water for drinking purposes, and pointed out that this is not effected by the filter plants ordinarily installed in buildings, schools and institutions. In the discussion, Mr. Charles G. Atkins (Chicago) stated emphatically that filters of the class mentioned are not germproof. He briefly referred to investigations made in determining what equipment to install in the Michael Reese Hospital; this plant filters 6,000 gals. per hour, 200 gals. being for drinking purposes.

The next paper, by Mr. Thomas Tait (Kansas City), called attention to the unsanitary features of the use of a cup or glass in common by a number of children. The use of the jet fountain was approved, in which no cup is used and the lips came in contact only with a stream of running water. Mr. C. B. Ball (Chicago) pointed out that the surface over which the water flows must not be allowed to become dry, and suggested the waste of water by continuous-flow fountains. In one style of fountain, with a small flow, the user closes the overflow and causes a jet 3 or 4 ins. high to rise from the fountain while he drinks. Mr. Davis (Washington) advocated the continuous flow; the water becomes warm when standing in the pipes and children will let it run until cool. An objection that has been made is the liability of injury from children knocking each other's heads down in the fountain nozzle while drinking. A member from Detroit said he had had that trouble, but now a janitor or teacher is at hand when the children are using the fountains during recess. As to waste of water by the continuous flow, he did not think cities having an abundant supply, such as those on the great lakes, should make this an objection, in view of the sanitary advantages. The Detroit schools have bib cocks over iron troughs; one school now has the continuous-flow fountains, and the city has been asked for an appropriation to equip all the schools with this device.

SEWAGE DISPOSAL.—Mr. Henry F. Shade (Vancouver, Canada) described a form of septic tank, adopted for residences, country hotels, etc. This paper, in part, was as follows:

> A few years ago the writer, knowing of several instances where cesspools had been in use for from five to seven years without the necessity of their contents being removed, and having heard of the septic tank experiments at Exeter, started out to investigate with a view of improving the cesspool. It was found that in every case where these pools did not require the removal of sewage at regular intervals, a heavy crust or scum had formed on the top, and the inlet pipe discharged either below the water level of the pool or was so placed that it did not disturb this scum. It was evident from this that the scum produced a septic action sufficient to disorganize a large portion of the organic matter in the sewage, and all that was required to complete the work was to encourage sufficient septic action to cope with and disorganize all the incoming sewage matter.
>
> The first improvements were to enlarge the tank and to submerge the outlet in the same manner as the inlet, at a depth of about 2 ft. below the water level. The result of this was closely watched; the effluent at first was fairly clear, but finally it gradually darkened, with considerable odor. With the inlet pipe submerged as above mentioned it would often become blocked at the elbow connecting with the horizontal pipe, as the sewage did not have sufficient force to pass down through 2 ft. of submerged pipe into the tank. By sounding the bottom of the tank it was found that a heavy black sediment had precipitated. It was evident that the inlet and outlet pipes were carried too far below the water line. Subsequently it was found that if the inlet pipe was brought about 12 ins. below the level it would neither disturb the septic scum nor become blocked; also that by raising the outlet to about the center of the depth of the tank, the effluent would not be polluted by the black sediment at the bottom, and at this depth there was no danger of the scum being removed through the outlet leg.
>
> This information was derived from tanks approximately 6 ft. square, intended for the capacity of from six to eight persons. Later it was found that, by building the tank in proportion to the amount of sewage to be treated and by elongating it so as to eliminate any current or movement in the tank, the scum could be kept absolutely undisturbed. These tanks were calculated on the basis of 40 gals. per capita per day, allowing 2 ft. of superficial area for each person.
>
> In localities where there are no facilities for draining off the effluent, and where the soil is of a sandy or porous nature, it is taken care of and distributed by a system of tile drainage or sub-soil irrigation. Ordinarily, it is better to place the tank on the highest ground possible, and as far from the house as convenient (although the latter condition is not imperative), so that if the effluent has to be percolated into the subsoil, its velocity will be greater through the tile drainage system, and consequently will be discharged over a greater area.
>
> For small septic tanks, filters or contact beds are not generally applicable, for the reason that they require considerable care and attention. For such conditions an underground system of drain tile, carefully laid out, with frequent openings to the surface for the admission of fresh air, is the most effective arrangement. A by-pass around the tank to the sewer line would encourage a draft down the openings and through the tile drain. In this way the effluent is completely aerated and freed from all dangerous pathogenic bacteria. This is, in my opinion, the best system of sewage disposal for isolated houses and will be found to overcome many difficulties which the use of the cesspit produces. It is simple, automatic, and without any syphonic or mechanical appliances. I have personally supervised the construction of at least 200 of such tanks and have yet to hear the first complaint of their not working satisfactorily.

Mr. B. J. Ashley (Chicago) said that the subsoil irrigation method of disposing of the effluent is not satisfactory unless in connection with flushing. With ordinary flow, one or two of the lines of pipe will take practically all the effluent. He had inspected a plant of this kind at the residence of Mr. Elkins, near Philadelphia, where two of the pipes were apparently doing all the work, and along them the moisture was working to the surface instead of being absorbed by the subsoil. In most of such systems, also, there is insufficient provision for aeration. A paper by Mr. A. C. Shaver (Pasadena, Cal.) on "Broad Irrigation with Sewage in Southern California," was devoted chiefly to the Pasadena sewage farm.

THE COATING OF CAST IRON PIPE.—The paper on this subject by Mr. Francis H. Wright (Chicago) referred particularly to soil pipe, and described the ordinary method of coating in a bath of tar. Lime water is added to the bath to improve the adhesion of the composition to the metal. Mr. Wright said, in part:

> In regard to the coating, there is divergence amongst ordinances. Some require asphaltum, some pitch, others pitch and asphaltum, and again painting with tar. Some specifications require shellac to be given to the pipe before the tar or pitch is applied, and some late ordinances require linseed oil only, or linseed oil and paraffine. Some ordinances require the pipe to be painted after the water test has been made, but this does not protect the interior of the pipe.
>
> Some cities prohibit the use of any coating, claiming that cast iron does not rust sufficiently to require it. This is not borne out by experience, and there is always probability of corrosion from sewage, which should be provided for. There is a dissatisfaction amongst inspectors with the present coatings, and I believe that the reason is on account of experiences with defects in pipes and fittings concealed by the usual coatings.

THE RELATION OF PLUMBING INSPECTION TO DISEASE.—At the evening meeting on Feb. 11, held at the Art Institute, an address was given by Dr. W. A. Evans, Commissioner of Health, of Chicago, on the relations between plumbing, plumbing inspection, and the germ theory of disease. He pointed out that in one of the districts of Chicago which has a sparse population but no sewerage and little house drainage, there is a very high rate of typhoid and infant mortality. From his investigations he has concluded that a population of 200 per acre where sewerage and drainage are provided is safer than 50 per acre where neither of these sanitary works exist. He closed his address by stating that in 1907 Chicago had 10,000 deaths due to bad-air diseases. The improvement of sanitation in regard to diseases of this character has not progressed as far as that in regard to water-borne diseases, and this is a matter which calls for the attention of sanitary engineers.

PUBLIC COMFORT STATIONS.—Following Dr. Evans, a paper was read by Mr. John K. Allen (Chicago) on the subject of public comfort stations. He discussed the necessity of these stations, and the special features of their design and equipment. The paper was illustrated by numerous stereopticon slides showing views and plans of stations in European and American cities.

MISCELLANEOUS PAPERS ON PLUMBING.—Several of the papers relating directly to matters connected with plumbing were of a character to interest engineers and municipal officers. Mr. W. S. Reed (Philadelphia) presented a paper

on "The Administration of a Plumbing Bureau," in which it was recommended that in all cases the plans and specifications for a system of drainage should be submitted to the bureau for approval. It is also important to keep complete and readily accessible records of work, and also complete records of plumbing. In this latter purpose, annual registration or licensing is to be recommended. As supplementary to this paper, Mr. Frank O. Peters (Chicago) described the Chicago system of records, illustrating the various notices, reports and certificates by stereopticon views. In the discussion, Mr. J. K. Allen suggested that the records of all departments should be coordinated, so that for any piece of property the record would show the reports of the water, sewer, health, plumbing, police, public works, and other departments or bureaus; this would be in many ways superior to the usual plan of each department keeping its own records independently of the others. Mr. C. B. Ball remarked that a complete and accurate system of plumbing records is necessary on account of the great amount and great aggregate cost of the work, and its relation to public health. It was also remarked that a city should pay particular attention to the inspection of the smaller jobs and cheaper class of work, where defective features are more liable to be met with. "The Plumbing Work of the U. S. Government on the Panama Canal Zone" was the subject of an interesting paper by Mr. C. L. Stockelberg (Panama). He described the crude equipment of the old French buildings, and the high class of work that is now being put in under the direction of the Panama Canal Commission. The relation of this sanitary work to the problems of getting and keeping laborers was also pointed out, but some of the earlier commissioners were slow to see the necessity or reasons for putting in extensive and high-class fixtures for the dwellings, hospitals, etc. In fact, it was thought by some that construction camp methods should be followed, but the results of the present plan have been such as to convince even the critics that this plan was the best.

A paper by Mr. Thomas S. Ainge (Lansing, Mich.) on **"Sizes of Soil Pipes for Dwellings"** brought out the fact that the sizes are usually adopted arbitrarily, and that there is no definite method used for determining the size in any particular case. Mr. C. B. Ball (Chicago) said that at Washington there are thousands of cases where 3-in. pipe is used with success, but the pipe must be straight. Another member said that at Detroit 3-in. pipe is allowed only under special conditions, but is satisfactory if properly placed. Mr. Cotter (New York) disapproved of any size less than 4 ins.; if the smaller size is used at all it is likely to be used in tenements and cheap buildings where the work may be of an inferior character. Trouble from clogging is then likely to occur, and to be left without remedy.

"Plumbing in Public Schools," by Mr. C. M. McHugh (Cedar Rapids, Ia.), was followed by a talk on "Details of Plumbing Design," by Mr. Charles B. Ball (Chicago). Numerous stereopticon views were shown illustrating good and bad, modern and old practice, and these were discussed and criticised by the members. In a paper on "The Illinois Plumbing Law," Mr. E. H. Donahoe (Peoria, Ill.) explained that the Attorney-General has ruled that under the wording of the law only a person engaged in the business of plumbing is required to be examined and licensed, and that an owner of a building can put in his own plumbing, even if he is not a licensed plumber. This opens the door for defective work, and an effort is being made to remedy this condition. Mr. Donahoe also thought that there should be one state examining board instead of several local boards, as some applicants who fail before one board will try others until they find one easy enough to pass and license them. Mr. Charles B. Ball (Chicago) described a new cast-iron soil pipe fitting, as a modification of the 45° double Y which is generally prohibited by city regulations. Instead of the two separate branches entering the main pipe by separate and opposite orifices, they combine to form one large orifice at their junction with the main pipe. Several other papers were presented which dealt with various practical details of plumbing work.

OFFICERS.—The election of officers resulted as follows: President, Edwin Quinn, St. Louis, Mo.; Vice-Presidents, Charles B. Ball, Chicago, and A. C. Shaver, Pasadena, Cal.; Secretary and Treasurer, Charles S. McCofker, 264 Frances St., Mobile, Ala. The next meeting will be held at Omaha, Neb.

A BROKEN RAIL was the cause of a railroad wreck on the Southern Pacific R. R. at Forest Grove, Ore., on Feb. 11, in which three persons lost their lives and 18 were injured.

A TORNADO swept through the southern part of Mississippi and Texas on Feb. 14, with accompanying loss of life and property. The town of Mossville, pop. 500, in Jones County, Mississippi, was almost entirely destroyed. This is the second serious tornado in this locality within the past three weeks.

A GRADE-CROSSING COLLISION between a Big Four passenger train and a Toledo & Western R. R. electric car at the Michigan Central crossing at West Toledo, Ohio, on the night of Feb. 15, caused the death of seven persons on the electric car and the injury of nine others. The electric car had slowed up for the crossing and the conductor who had gone ahead to watch the tracks signaled the motorman to stop, but the motion was either misunderstood or disregarded for the car was brought ahead just as the railroad train came along the main track.

EXPLOSIONS of four different varieties were the cause of many casualties during the past fortnight. A nitroglycerine explosion at the works of the Standard Explosives, Ltd., on Ile Perrot, near Vaudreuil, Can., on Feb. 11, caused the death of nine workmen. In a mine explosion in the mine of the Moody Coal Co., at South Carrollton, Ky., on Feb. 10, nine miners were killed and another will die. A starch factory in Providence, R. I., blew up on the afternoon of Feb. 12 and caused the death of five workmen. The cause of the explosion is not certain, but it is supposed that the mixing starch became in some way ignited and exploded. Two explosions in blast furnaces of the Monongahela furnace at McKeesport, Pa., on Feb. 12, caused the death of two workmen.

THE PERCENTAGE OF IDLENESS among 92 representative labor organizations in New York City at the end of December, 1907, was much greater than in previous years. Some 34%, or nearly 23,000 out of 66,000 members, were idle, as compared with 13% in 1906, 7% in 1905, and 18% in 1904. Of the men represented as out of work on Dec. 31, 1907, it was stated that 90% were idle on account of lack of work.

FORTY-ONE BIDS FOR FLYING MACHINES of the "heavier-than-air" variety for the Signal Corps, U. S. A., were received up to Feb. 1, and turned over to the Board of Ordnance and Fortification. This board is reported as having accepted three bids for aeroplane machines, whose makers, prices and times of construction are as follows:

Messrs. W. and O. Wright, Dayton, O., $25,000; 200 days.
Mr. A. M. Herring, New York City, $20,000; 180 days.
Mr. J. F. Scott, Chicago, Ill., $1,000; 185 days.

Of the 41 bids received these three alone satisfied the specifications drawn up when bids were advertised. [These specifications were printed in Engineering News, Jan. 2, 1908.] The Wright Brothers and Mr. Herring have long been identified with the development of aeroplane developments, while Mr. Scott, in comparison, is comparatively little known as an experimenter and is willing to construct his machine at this absurd figure, according to press reports, through a patriotic desire to furnish the army with a machine at the mere cost of the material entering into its construction.

According to the conditions under which bids were received, the plans of these machines are not to be published. Before any machine is accepted it must pass a thorough trial at Fort Myer, Va. It is reported that only $25,000 is available for the purchase of airships of this type, but it is expected that an additional appropriation can be secured from Congress to cover the cost of the three machines.

A PETITION FOR A REHEARING in the Cameron Septic Tank Patent case (Eng. News, Jan. 23, 1908,) was denied to Saratoga Springs, N. Y., by the U. S. Circuit Court of Appeals on Feb. 7, and on Feb. 11 the lower court, in accordance with the order of reversal by the Court of Appeals, entered a decree enjoining Saratoga Springs from operating its septic tank in infringement of Claims 1, 2, 3, 4 and 21 of the Cameron patent No. 634,423. The court also appointed Mr. W. S. Doolittle as Master, to report to the court "the extent of said infringement and the profits, gains and advantages" derived by Saratoga Springs therefrom. The lower court at the same time decreed that Claims 5, 6, 7, 8, 11, 12, 20 and 22 were not infringed by Saratoga Springs. We are informed by Mr. W. A. Pauling, of Gifford & Bull, 141 Broadway, New York City, attorneys for the Cameron Septic Tank Co., of Chicago, that the company has agreed to a suspension of the injunction to Feb. 25, 1908. The suspension is granted to enable Saratoga Springs to determine upon its future course of action. Information received from other sources indicates that Saratoga Springs will make a strenuous effort to take the case to the U. S. Supreme Court.

COOPERATION IN HEALTH-PROTECTIVE WORK between the national, state and local governments was provided for at the Providence meeting of the Executive Committee of the National Municipal League last November, when a resolution was adopted providing for the appointment of a committee to consider the subject in conjunction with a similar committee of the American Civic Association. The membership of the committee has just been announced, as follows: Dr. Alexander C. Abbott, Chief of the Bureau of Health, Philadelphia, Pa., Chairman; Dr. George A. Soper, M. Am. Soc. C. E., New York; Prof. W. T. Sedgwick, Massachusetts Institute of Technology, Boston, Mass.; George Burnham, Jr., Philadelphia, Pa.; M. N. Baker, President of the Board of Health, Montclair, N. J.; Prof. Irving Fisher, Yale University, New Haven, Conn.; Dr. George W. Goler, Health Officer, Rochester, N. Y.; Clinton Rogers Woodruff, Secretary of the National Municipal League, North American Building, Philadelphia, Pa., ex officio.

THE USE OF SEWAGE FOR CONDENSING PURposes has been adopted at Edinburgh, Scotland, in connection with the McDonald Road power station of the Electric Lighting Committee of the Town Council. The city authorities entered into arrangements with the Water of Leith Purification Commissioners, by which a shaft 26 ft. in diameter and 35 ft. in depth was sunk to a 6½-ft. brick sewer, under the direction of the Commissioners. This shaft is lined with cast-iron rings. At the foot of the shaft a suction pit 5 × 8 ft. in plan was built, and provided with copper wire screens. Centrifugal pumps draw water from the pit through four 18-in. pipes leading to the condensers in the near-by power station. The condensing water is returned to the shaft through a 26-in. pipe and discharged into a compartment 4 ft. square provided with ¾-in. × 1½-ft. × 4-ft. baffle plates, designed to aid in throwing off gases from the condensing water. Motor pumps are provided for sending the gases to the furnace of the power station. The normal dry-weather flow of the sewer in question is about 12,000 U. S. gals. per minute. A weir diverts the flow of sewage through the streams into the suction pit. The cost of diverting the sewage to the electric station was about $6,000. Work was begun in August, 1907, and has but recently been completed. As an alternative to the plan carried out, the Electric Lighting Committee considered various propositions, including bringing fresh water from several sources, taking water from the city mains, and constructing a pumping plant and laying a force main from the sea to the station. The notes here given are based on an article in the London "Contract Journal" of Jan. 29, 1908.

A MATERIAL ENLARGEMENT OF BIRMINGHAM, Ala., will be made in the fall of 1909, by the consolidation with it of the following municipalities: North Birmingham, Avondale, Woodlawn, East Lake, Elyton, Greymont, Pratt City and West End. In addition, considerable unincorporated territory will be added to the area of the city. These municipalities, so far as they are provided with sewerage facilities, were already united with Birmingham to the extent that they were jointly interested in the county trunk sewer and sewage disposal works built primarily for Birmingham a short time ago. Mr. Julian Kendrick, M. Am. Soc. C. E., is City Engineer of Birmingham.

THE SPEED RECORD FOR ARMORED CRUISERS was broken on Feb. 15 by the U. S. S. "North Carolina" in her trial trip off the mouth of Chesapeake Bay. The "North Carolina" completed a four-hour trip in heavy seas at an average speed of 22.48 knots per hour. The former record was held by the U. S. S. "Pennsylvania" with a speed of 22.44 knots per hour.

A LARGE SUBMARINE TORPEDO BOAT is reported to have been contracted for by the Navy Department with the Lake Torpedo Boat Co. This boat is the invention of Simon Lake, whose name has been familiar in discussions of submarine boats for many years. Mr. Lake's idea is to provide a boat rising and falling on an even keel as contrasted with the diving types. According to numerous press reports the requirements are unusual and rigid, although laid down by the company with no guarantee from the government. The boat will be, if built, about 161 ft. long and of 500 tons displacement. A surface speed of 16 knots and a submerged speed of 9.5 knots is expected. A surface cruising radius of 3,000 mi. is said to have been made possible by a

new type of gasoline storage tank. A forward air compartment will be so arranged that the men can leave the boat while it is submerged. The contract is reported to call for delivery in 27 months, but the builders claim the ability to reduce this figure to 18 months. The boat will be constructed at the Bath Iron Works, Bath, Me.

COAL PRODUCTION in the United States in 1907, according to a bulletin issued by the U. S. Geological Survey, amounted to between 450,000,000 and 460,000,000 short tons. There was an increase of about 20% in the production of Pennsylvania anthracite. The financial stringency during the latter part of the year, curiously enough, seemed to have no effect on the output of anthracite. Both the anthracite and bituminous fields were almost entirely free from labor troubles during the year.

PERSONALS.

Mr. Philip J. Nash has recently taken charge of the Sales Department in Chicago of the Ernst Wiener Co., of New York.

Mr. John Fritz, the veteran iron master, has been elected a member of the Board of Trustees of Lehigh University.

Mr. Alex Bonnyman, Chief Engineer of the Atlanta, Birmingham & Atlantic R. R., has been appointed General Manager of that road.

Mr. Robert McF. Doble, consulting engineer on hydro-electric power development, has removed his offices from Colorado Springs to the Majestic Building, Denver, Colo.

Mr. S. Bent Russell, M. Am. Soc. C. E., of St. Louis, has been appointed Chief Engineer and Superintendent of the Louisville Water Co., to succeed the late Charles Hermany.

Mr. A. H. Swartz has allied himself with the selling force of the Rust Boiler Co., of Pittsburg, Pa. Mr. Swartz formerly has been connected with the Carnegie Steel Co. and the Republic Iron & Steel Co.

Mr. S. W. Huff, until recently General Manager of Virginia Passenger & Power Co., has been elected President of the Coney Island & Brooklyn R. R. Co. to succeed Mr. John L. Heins who recently retired.

Mr. Wynn Meredith, M. Am. Inst. E. E., has been admitted to the firm of Sanderson & Porter, Contractors and Engineers, and will take charge of their western office in the Union Trust Bldg., San Francisco, Cal.

Mr. E. F. Layman has retired from the position of Sewerage Engineer of the city of Cincinnati and has opened an office in the Blymer Building in that city for general practice as civil engineer, with special attention to sewerage, water supply and municipal improvements.

Mr. John Hays Hammond, President of the American Institute of Mining Engineers, has resigned, because of ill health, from his active duties as Engineer-in-Chief of the Guggenheim Exploration Co. His duties have been taken over by his former first assistant, Mr. A. Chester Beatty, M. Am. Inst. Min. Eng.

Mr. Allen N. Spooner, M. Am. Soc. C. E., has been appointed Dock Commissioner of the city of New York, to succeed Mr. John A. Bensel, M. Am. Soc. C. E., who was recently appointed Commissioner of the Board of Water Supply of the city. Mr. Spooner is a graduate of the Columbia School of Mines and has been connected with the Dock Department for 21 years.

The Underwriters' Laboratories, Inc., have moved their New York office from No. 29 West 39th St. to 135 William St., where the offices of the National Board of Fire Underwriters are also located. Mr. George E. Bruen has been appointed Engineer for the Underwriters' Laboratories, Inc., to have charge of the business of that corporation in and around New York City.

Mr. L. R. Pomeroy, M. Am. Soc. M. E., has resigned his position with the General Electric Co., where for the past seven years he has been in charge of the introduction of electric motive power in railway shops, and has been appointed Assistant to the President of the Safety Car Heating & Lighting Co., Mr. Robert M. Dixon, M. Am. Soc. M. E. In his new position Mr. Pomeroy will have charge of the Sales Department.

Mr. Hugh Bonner has been appointed Fire Commissioner of the city of New York to succeed Mr. Francis J. Lantry, resigned. Mr. Bonner has been connected with the New York Fire Department since its organization, with the exception of a short period when he was engaged in reorganizing the fire department of Manila, P. I. He has served in all capacities from volunteer up to chief and at the time of this most recent promotion was Deputy Fire Commissioner.

Mr. L. H. Taylor, who as Supervising Engineer in the U. S. Reclamation Service, has had direct charge of the "Truckee-Carson" irrigation project in Nevada from its inception in 1902, until the completion of construction in the latter part of 1907, has resigned from that position and has opened offices in the Chronicle Building, San Francisco, California, where he will devote himself to consulting and general engineering practice. Mr. Taylor is still retained as Consulting Engineer by the Reclamation Service, but will give the major part of his time to private practice.

Mr. C. F. Harding, Assoc. M. Am. Inst. E. E., has been appointed Professor of Electrical Engineering at Purdue University, succeeding the late Prof. C. P. Matthews as head of the school. Prof. Harding is a graduate of Worcester Polytechnic Institute and has had a varied experience both as a practicing engineer and as a teacher. He has been connected with high tension railway work in New England, with the Fort Wayne Electric Co. and Stone & Webster, consulting engineers of Boston. For a short while he was Associate Professor of Electrical Engineering at Cornell University.

Obituary.

William J. Seaton, Jr., Assoc. M. Am. Soc. C. E., the Second Vice-President of the C. W. Hunt Co., died at his home at Clifton, Staten Island, on Jan. 18, at the early age of 36 years. Mr. Seaton entered the employ of the company 17 years ago as an office boy and was continuously in its service until his death.

Robert W. Hamilton, for a number of years Superintendent of the Brooklyn Water-Works System, died on Feb. 12 at Dalton, Mass., at the age of 85 years. Mr. Hamilton had been connected with the construction of many of the large water systems of this country and for many years was Consulting Engineer to the Calumet & Hecla mines.

David Parish Barhydt, a pioneer railroad man in the United States, died at his home in New York on Feb. 13 at the advanced age of 92 years. Mr. Barhydt had been President of the Erie & Kalamazoo R. R., the first road to be built west of Lake Erie, and had also been one of the prime movers in the construction of the first horse-car line in New York City.

George T. Dunlop, President of the Capital Traction Co., of the District of Columbia, died on Feb. 5, at his home in Washington, aged 63 years. Mr. Dunlop had been long connected with the street railways of the District and was largely instrumental in bringing the system of which he was President to its present high standing among the street railways of the country.

Rear Admiral Montgomery Fletcher, formerly Chief Engineer of the U. S. Navy, died Feb. 13 at his home in Washington. Chief Engineer Fletcher entered the service as a Third Assistant Engineer in 1850, and served through the Civil War as Chief Engineer. During the period from 1890 to his retirement with the rank of Commodore, in 1892, he was on duty with the Bureau of Steam Engineering. Since his retirement Admiral Fletcher has had no active duty.

James D. Layng, Vice-President of the Cleveland, Cincinnati, Chicago & St. Louis R. R., better known as the "Big Four," died at his home in New York on Feb. 12, aged 74 years. Mr. Layng was graduated from the Western University of Pennsylvania in 1849 and began his engineering career as a rodman in the engineer corps of the Ohio & Pennsylvania R. R. He was engaged in maintenance-of-way engineering until 1856 when he was appointed Superintendent of the Cleveland & Mahoning R. R. He served in various administrative capacities on the middle western roads until 1890, when he assumed the Vice-Presidency of the "Big Four." At the time of his death he was connected with the directorate of many railways of this country.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 17-19, 1908. Annual convention at Chicago, Ill. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago.

AMERICAN RAILWAY ASSOCIATION.
April 22, 1908. Semi-annual session at New York City. Secy., W. F. Allen, 24 Park Place, New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1-2, 1908. Annual meeting at Albany, N. Y. Secy., Joseph W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-16, 1908. Annual meeting at Washington, D. C. Secy., John M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26, 1908. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26, 1908. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

SOCIETY OF CHEMICAL INDUSTRY.—At the regular meeting of the New York Section, to be held at the Chemists' Club, 108 West 55th St., New York City, on Friday, Feb. 21, at 8:15 o'clock, three papers of interest to engineers will be presented. These are, "The Manufacture of Ferro-chrome in the Electric Furnace," by Mr. Roland Carlberla, Chemical Department, Columbia University; "The Injury to Vegetation by the Fumes from Chemical Factories," by Mr. Chas. Baskerville, of New York City; "The Influence of Sunlight on Paints and Varnishes," by Maximilian Toch, New York City.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The monthly winter meeting of the association for February was held on Wednesday, Feb. 12, at the Hotel Brunswick, Boston. After the usual lunch most of the afternoon was devoted to a series of papers and talks on the water filtration plant at Lawrence, Mass. Many lantern slides were shown.

Mr. Morris Knowles, M. Am. Soc. C. E., Chief Engineer of the Bureau of Filtration, Pittsburg, Pa., was the first speaker. He recounted the early history of filtration at Lawrence and gave a general idea of what has been done there since then. Mr. Arthur D. Marble, City Engineer of Lawrence, described the work of dividing the original filter area of 2½ acres into three compartments by means of walls, and also described the new covered filter. The latter has an area of ¾-acre and is on the other side of the pumping station from the old uncovered filters. The new filters are of the standard form, with concrete floors, piers and groined arches.

The many discouraging and dangerous delays experienced by the Lawrence Water Board in getting necessary authority from the City Council to provide an additional supply of filtered water, were outlined by Mr. Marble. When the contract was finally awarded, in 1906, provision was made for completing the filters in November of that year. The work, however, was delayed a year or more beyond the contract time, and in March, 1907, a portion of the completed filter roof collapsed. The delay in the completion of the contract combined with the water shortage in Lawrence, made it necessary for the city to buy water from adjacent municipalities during the winter of 1906-07, at a total cost of some $10,000. The speaker cited this incident, together with others connected with the construction of the new filter, as an example of the unfortunate results likely to occur when the city is compelled, for one reason or another, to award a contract to the lowest bidder.

Mr. Sanford E. Thompson, M. Am. Soc. C. E., outlined at some length the methods and results of an investigation, made by him, of the collapse of the filter roof. One of the contributing causes of the failure, in his opinion, was that, contrary to specifications, concrete was placed in the roof in freezing weather, and that this weather was followed by very cold weather which extended nearly up to the time of the removal of the arch centers. Another cause of the failure was the removal of the centering nearest the filter wall before the centering in the central area was taken down. This, also, was contrary to specifications. Neither of the causes alone, Mr. Thompson stated, would have caused the failure; but the combination of the soft concrete and of there being no centering under the outer arches to take up the thrust, was too much for the stability of the roof. A third cause of the failure appears to have been the use of gravel, for the concrete, which contained a large percentage of particles less than ¼-in. in diameter. This also was against the specifications. Mr. Thompson pointed out that if in a 1:3:5 concrete, as specified, 20% of the gravel was of particles less than ¼-in. in diameter, the proportions would really be 1:4:4. Besides the small size of some of the gravel at Lawrence, Mr. Thompson found that many of the gravel particles were coated with a thin film of dirt.

Mr. Stephen DeM. Gage, of the Lawrence Experiment Station, showed a large number of lantern slides taken while the new filter was under construction, and he also exhibited on the screen some tables and diagrams showing the beneficial effect of filtration on the typhoid death rate at Lawrence. Mr. M. F. Collins, Superintendent of the Lawrence Water-Works, explained two high points in the Lawrence typhoid diagrams in 1903 and 1907 respectively, as follows: In 1903 there were over 40 cases of typhoid fever among the employees of the Pacific Mills; a later investigation showed a leak in a check valve which had been placed between the city and the mill water-supply mains—the latter taking unfiltered water from the polluted canal. In 1907, out of a total of 129 cases of typhoid in the city, 48 cases and 7 deaths were among employees of the Washington Mill, while of the total number of cases 76 drank canal water. Mr. Collins explained that in the mills both the city water supply and the mill supply of polluted water were available to employees, and that as the mill supply was allowed to run freely it was cooler than the city supply and was therefore used by the employees regardless of its danger.

Mr. Robert Spurr Weston, Assoc. M. Am. Soc. C. E., gave a brief account of a recent trip to Europe, during which he made a special investigation of means employed there for the removal of iron and of manganese from water. Aside from his remarks on this subject, Mr. Weston spoke of three points of special interest that he noted in his visit to European water-works: (1) At a large number of boiler plants visited by him it was impossible for the firemen to open the furnace doors without first closing the chimney dampers—the object of this being to prevent emission of smoke from the chimneys; (2) on suction mains, in place of flange joints, the speaker observed the use of regular bell-and-spigot joints, with rings of pure Para rubber instead of lead; (3) the pleasing architectural appearance of towers supporting water tanks was particularly noteworthy. Well-designed masonry structures were in general use for this purpose, and the usual practice was to carry the shell masonry up to enclose the tank.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. February 20, 1908.

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REVIEWS.

Alcohol, Steam and Gas Engines.

Reviewed by LIONEL S. MARKS.*

CARBURETING AND COMBUSTION IN ALCOHOL ENGINES.—By Ernest Sorel. Translated from the French by Sherman M. Woodward, Formerly Professor of Steam Engineering, State University of Iowa, and John Preston. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5 × 8¼ ins.; pp. 269; 26 illustrations in the text. $3; English price, 12s., 6d., net.

THERMODYNAMICS OF THE STEAM-ENGINE AND OTHER HEAT-ENGINES.—By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. Fifth Edition, rewritten. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 533; 117 illustrations in the text. $5; English price, 21s., net.

THE GAS ENGINE IN PRINCIPLE AND PRACTICE.—Consisting of Articles Published in "Gas Power" and Other Descriptive Matter and Tables. Written and Compiled by A. H. Goldingham, Mechanical Engineer and Expert, Author of "Oil Engines." St. Joseph, Mich.: Gas Power Publishing Co. Cloth; 6 × 9¼ ins.; pp. 195; 107 illustrations in the text. $1.50.

The recent action of the United States Congress in exempting denatured alcohol from any internal revenue tax has resulted in the immediate lowering of its market price to about one-fifth of its previous price and has suddenly put upon the market a fuel which, in many respects, is particularly well adapted for use in internal combustion motors. Under these circumstances it is a matter of congratulation, to those engineers who are called upon to deal with this new fuel, that there has been made so very thorough and comprehensive an investigation of the properties of alcohol as is recorded in the book before us. These investigations were carried out principally by M. Sorel under a commission from the French Minister of Agriculture, in connection with the alcohol engine trials instituted by the Department of Agriculture in 1901 and 1902. The physical and chemical properties of alcohol, the effectiveness of various methods of carbureting, the actions of heat, of metals and other factors on alcohol were so exhaustively investigated that there appears to be little further to be done in those directions. It now remains for the engineer to make use of the wealth of material that is placed at his disposal. It is not too much to say that this is the standard book on the subject, and that a great number of years must elapse before it can be neglected by any one who has to design an alcohol engine of maximum efficiency.

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The opening chapters treat of the general phenomena attending chemical reactions (particularly the exothermic reaction called combustion), and of the laws governing the velocity and acceleration of such reactions, so far as they have been determined by the physical chemists. An explosive action is defined as one in which the velocity of reaction and the corresponding elevation of temperature continually increase when the action is once initiated. The influences of temperature, of pressure, of the volume and form of the containing vessel, of the proportions of the reacting substances and of the presence of neutral gases on the rate of combustion of gaseous mixtures are discussed in the light of the various investigations which have been made in these fields.

The discussion of the velocity of combustion is not so clear or so full as it should be. The author refers to the classic investigations of Berthelot and Vieille and of Mallard and Le Chatelier, but he does not seem to be acquainted with the later, and in many respects more important, work of Dixon on the velocity of propagation of explosions. He fails to distinguish clearly between (1) the comparatively slow propagation which occurs in his own experiments and in those of Bunsen and of Michelson (experiments in which the velocity of propagation of the flame is balanced by the velocity of flow of the combustible mixture, so that the flame remains stationary) a propagation in which the conductivity of heat from layer to layer of the gas is the principal factor in spreading the combustion, and (2) the enormously rapid propagation which occurs when the rate of reaction is so great that the resulting compression wave is sufficient in itself to raise the mixture to the temperature of combustion, with the consequence that the explosion travels with the same velocity as the compression wave. This latter method of propagation of combustion—the method of the "explosion-wave"—can occur and does occur frequently in gas engine cylinders and is one of the principal causes of the kind of hammering to which the author refers (on page 81), but to which he assigns a different cause.

The experiments of M. Sorel on the velocity of propagation were carried out with benzine, with alcohol of various strengths, with mixtures of alcohol and benzine and with gasoline—in each case with various amounts of air, to determine the effect of diluting gases. The absolute results he obtains, which curiously enough are about the same in every case (viz., a maximum velocity of about one meter per second, occurring in each case with an excess of air of about three-tenths over that theoretically necessary for combustion) are applicable only to the conditions of the experiment, i. e., combustion inside glass tubes; the comparative results, however, are probably accurate under actual conditions of engine running, as is evidenced by the recent alcohol engine tests of Lucke and Woodward, which show that the point of ignition should be the same for both gasoline and alcohol.

In connection with the French alcohol engine tests of 1902, careful analyses of the exhaust gases were made by M. Sorel to determine the degree of completeness of combustion in the various engines tested. The examination of the result of these analyses shows the influence of the amount of air present on the completeness of combustion of both the hydrogen and the carbon. These results are unique and very noteworthy.

Coming next to the subject of carbureting and carbureters, after a preliminary classification and description of the existing forms of carbureters, the author gives the results of his extensive investigations on the fractional distillation of various oil fuels, on the vapor pressure of various fuels at different temperatures, on the air necessary for vaporization of the various fuels at different temperatures, on the rapidity of such evaporation and on the quantity of heat absorbed in vaporization. Special apparatus was constructed for testing quantitatively the efficiencies of the various methods of carbureting by surface evaporation, by trickling, by spraying and by bubbling. The results presented comprising investigations on various petroleum products as well as on alcohol of different strengths, carried out with the various methods of carbureting and at different temperatures, determining in each case the composition of the carbureted air and to what extent selective evaporation went on, these results constitute the most valuable and considerable mass of information on the subject of carbureting that has appeared up till the present time.

The last five chapters of the book contain the results of certain investigations on the influence of various factors on the chemical composition of alcohol vapors and their derivatives. The principal factors so considered are (1) moderate temperatures, (2) temperatures below that of combustion in the presence of oxygen, (3) metals in the absence of free oxygen. These chemical studies throw light on some of the minor phenomena attending the use of alcohol in heat engines.

Among the minor errors noticed are some inconsistencies in the table on page 71, and an insistent misspelling of the name of the German engineer, Slaby.

Messrs. Woodward and Preston are to be congratulated not only on having accomplished an excellent piece of translation, but also on having rendered more available to English readers the very valuable work of M. Sorel.

The first edition of Peabody's Thermodynamics of the Steam Engine appeared eighteen years ago and established itself at once in the first rank of English text-books on that subject. It was, however, ill-balanced in some respects, from the point of view of the student. There were parts, such as the elaborate treatment of the results of Regnault's experiments on saturated vapors, which were of interest to the physicist, but which merely wasted the time and dulled the energies of the engineering student for whom the book was primarily intended. In the fifth edition, which is now before us, we are glad to welcome a book which, by the removal of much superfluous matter and a judicious rearrangement, has been rendered much more suitable to the needs of the student of engineering. There are few subjects which lend themselves so readily to the multiplication of formulas as pure thermodynamics, but the number of such formulas that is useful to the engineer who is not engaging in thermodynamic research is comparatively small. The average student is bewildered by a mass of formulas, even when their relations have the beautiful logic and symmetry of the thermodynamic equations. Moreover, the elementary conceptions of thermodynamics are assimilated with difficulty by the average student. It is therefore peculiarly necessary in a text-book of thermodynamics that the presentation of the fundamental ideas should be, as far as possible, lucid, simple, and unencumbered by non-essentials. In these directions the new edition still leaves something to be desired in order to bring the introductory chapters up to the same degree of excellence as the chapters dealing with the applications of the fundamental laws.

Professor Peabody is to be congratulated on having brought his book thoroughly up to date in practically all its parts. This is particularly the case in the chapter on superheated vapors, which includes not only the results of the investigations of Knoblauch and Jakob on superheated steam, but also the results of the investigations of Thomas and Short. The author was fortunate enough to obtain an advance copy of the report on the latter investigations in time to insert that very valuable work in his book.

Internal combustion motors were almost entirely neglected in the earlier editions, but they have now a chapter devoted to them in which

there is a great deal that is descriptive of mechanisms, of methods of operation, of gas producers and other non-thermodynamic matters.

The most important addition to this book is in the final chapters, devoted to the flow of steam and its application to steam turbines. The results of the investigations of Büchner, of Stodola, of Rosenhaim, of Lewicki, and others on the flow of steam in nozzles are presented for the purpose of determining the coefficient of friction to be used in the design of steam nozzles. The dynamic as well as the thermodynamic theory of the various types of steam turbines are considered in some detail and there is considerable discussion of the losses occurring in actual turbines, their economic performance, dimensions and design; altogether this final chapter gives a very good summary of the principal factors governing turbine design.

There are frequent references throughout the book to the research work which is being done at present in Germany and which is being published in the Mittellungen über Forschungsarbeiten of the Association of German Engineers (Verein deutscher Ingenieure). As this work is, perhaps, the most important body of research work that is being carried out on engineering problems at the present day, the references in Professor Peabody's book should be of considerable service in directing the attention of students to this source of much valuable information.

It is gratifying to find that this book, which has done such good service in the past, has taken on a new lease of life and prepared itself for a still wider utility.

The avowed purpose of Mr. Goldingham's book is to supply the non-technical reader with that information about gas engines that he is likely to desire. With this in view, all theoretical considerations are omitted and the descriptions of processes, constructions and methods of operation are strictly limited in scope. The subjects dealt with are the existing types of engines, valves and valve motions, governors, igniters, self-starters, testing, oil fuels, gas producers, installation, utilization of waste heat and operation. The work is well done, well illustrated and contains many of the results of modern practice, but it is essentially a book for the amateur owner of a gas engine or automobile rather than for the professional engineer.

Animadversions on the Panama Canal.

RETRIEVAL AT PANAMA.—By Lindon W. Bates, Author of "Project for Panama Canal," "Terminal Harbors, Panama Canal," "Panama Canal, System and Projects," "The Crisis at Panama," etc. For sale by The Technical Literature Co., 220 Broadway, New York City. Cloth; 6 × 9 ins.; pp. 554; illustrated. $5.

If we may believe the author of this book, everything which the United States has done at Panama, from beginning to end, has been a mistake. We have searched through his 550 pages to find a good word for somebody. For Burr or Parsons or Shonts or Wallace or Stevens or Goethals, or even Col. Gorgas; but our search has been in vain. Not one of those who have planned and wrought for the great work with engineering skill and diligence and with authority to decide upon elements of design appear to have been anything but stupid, ignorant blunderers.

Now we can readily believe that mistakes may have been made at Panama in various ways and by various men. Nobody is infallible, and few engineers claim to be. There have been, very likely, faults of organization and of method, for we never heard of any great engineering work or any other work that was conducted with absolute perfection.

But when one looks back over the history of the canal enterprise and asks what abler men could have been chosen to plan and direct the work, to decide on the type of canal to be built and to settle the details of construction, we do not see how an improvement could be made. No one (unless it be the author of this book) doubts that the responsible engineers at the head of the Panama enterprise, from the time the United States took hold, have had the confidence of the engineering profession as well as of the public. If the Panama task were to be undertaken anew and the choice of the engineers to be placed in responsible charge were left with the engineering profession, we question whether better men would be selected.

The author of this book had his own pet plan for building the Panama Canal. He submitted it to the International Board of Consulting Engineers, which gave him a hearing and full opportunity to say all he had to say in support of his plans; and then proceeded with the work they were appointed to do.

Since then Mr. Bates has been diligent in his published criticisms of everything done in connection with the Panama enterprise. He published a year ago, in the "New York Press," a voluminous series of articles on this line; and it is these articles, more or less revised, which are here reprinted in book form.

The literary style of these criticisms is unique. It reminds us at once of Tom Lawson and Poultney Bigelow. Like the work of those eminent authors, too, it somehow fails to carry conviction to the mind of the readers.

As one reads this book he is confronted with a dilemma. Have all the distinguished engineers who have been connected with the Panama work done nothing but commit colossal blunders? Were they incompetent to perform engineering tasks of a sort in which they had already won wide reputation? Either this must be the case or else Mr. Bates—to put it mildly—is the victim of error. The theory of mathematical probabilities would certainly indicate that the one man rather than a score or a hundred was the sufferer from a beam in his eye.

Gilbreth's Field System.

FIELD SYSTEM.—By Frank B. Gilbreth, M. Am. Soc. M. E. New York and Chicago: The Myron C. Clark Publishing Co. Leather; 4¼ × 6¾ ins.; pp. 194; illustrated. $3, net.

Mr. F. B. Gilbreth, a well-known general contractor, instructs his field employees in their duties by a printed book of rules, instructions, helpful pointers, cautions, etc. This book is now printed for general circulation, supplemented by a prefatory essay from the pen of Mr. J. P. Slack. It forms a valuable contribution to the literature of contracting, and commands the interest of contractor, engineer or student, whatever branch of professional work he may be engaged in. Reflecting more or less fully the administrative methods by which Mr. Gilbreth manages his contract work, large as well as small, and through which he secures (or aims to secure) from the management of his local superintendent the same results which his own personal supervision of the work would obtain, it should prove stimulating to every one concerned in the conduct of engineering work.

The reader must equip himself with a certain amount of charitable sentiment in order to be in a frame of mind to appreciate the book. Its arrangement is heterogeneous and confused, in parts, which fact the reader must discount if he would get a proper understanding of its contents. To take a mild instance: The general rules for employees, which are apparently mandatory and absolute, are suddenly broken in upon by the suggestion that the value of brick per thousand varies with slight differences in thickness or width. Similar jumps appear in the general plan; for example, rules for the important matter of dealing with changes in architects' plans are sandwiched in between some suggestions about batter boards and instructions for placing the superintendent's telephone, and the latter are followed by a paragraph on prizes for suggestions from workmen and a rule stating that "the front side of handles of rubber stamps must be cut off flat."

Perhaps the part of the book which will prove of most interest is the full description of the system of correspondence, reports and accounting sheets which pass between field and central office. The forms used, about a dozen in number, are reproduced in fac-simile, and the text gives detailed directions for filling out the blanks and for the disposition of the several (differently colored) manifold (carbon-paper) copies. There is a form for a Daily Letter to the central office, for materials, for cost reports, for workmen's time-sheets, for orders, for requisitions, for the pay-roll, for teamsters' receipts, for tool lists, for quotations, for a weekly cash account and for records of shipments, besides letter heads and half a dozen accessory blanks. The forms are so devised as to post the home office on all transactions in connection with the work in progress, and at the same time keep the superintendent's own attention directed to the facts and conditions which he must provide for if the work is to go on smoothly and without delays. The system of forms is rather complicated, and requires the reader's close study to understand its details and its inter-relation.

An essential part of the field system is the plan of maintaining the principal employees on steady pay, work or no work. The rules and instructions for these men form an interesting feature of the book. Other employees are kept track of by report cards, made out by the superintendent when a man is discharged, which give his rating, his special aptitude, etc., so that when men are wanted the file of these cards in the home office gives a directory of efficient workmen.

The further interest in the book lies in the instructions and suggestions to workmen. In these, brick masonry work and the care of hoisting engines, boilers, drills and compressors are covered in detail, while other trades are given only a few scattered suggestions or none at all. A compendium of directions for excavation work, for applying roofing, for carpenter work, etc., would doubtless draw a largely increased number of readers.

CEMENT PIPE FOR SMALL IRRIGATING SYSTEMS AND OTHER PURPOSES.—By G. E. P. Smith. Bulletin No. 55, Agricultural Experiment Station, University of Arizona. Tucson, Ariz.: The Experiment Station. Paper; 5¾ × 9 ins.; pp. 167 to 184; five illustrations in the text.

There is probably no locality in this country where a good, cheap concrete pipe, which can be made anywhere with unskilled labor, is of so much value as in the arid and semi-arid lands of Arizona. The future of the state depends upon irrigation, not only upon the monumental projects of the government but also upon the secondary systems on the individual farms and branches. It is therefore a very necessary work that the local experiment station has reported in the above noted bulletin. The account of the experiments is written in non-technical language and contains details of home-manufacture and costs which will enable the small operator to

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Elastic Arch Analysis.

ANALYSIS OF ELASTIC ARCHES.—Three-Hinged, Two-Hinged, and Hingeless, of Steel, Masonry, Reinforced Concrete. By Joseph W. Balet, Consulting Engineer. New York: The Engineering News Publishing Co. London, England: Archibald Constable & Co., Ltd. Cloth; 6 × 9½ ins.; pp. 316; folding plates and text illustrations. $3, net.

American technical literature has hitherto possessed no treatise on the application of elastic analysis to the design of arches. All of the text-books on bridge design give some—more or less satisfactory—presentation of theory and method, but none pretends to a full treatment. And, though the subject is extensive and complex enough to demand a large volume by itself, we have had no such work. Almost the same might be said of the presentation of arch theory alone, without the application, although Professor M. A. Howe's early work represents an ambitious attempt in this direction. The only elaborate discussions, both of theory and of application, are found in German books and periodical literature, and naturally this matter is available to but few engineers in America.

Mr. Balet has attempted to fill the gap as far as concerns the application. The complexity of the subject matter made it seem necessary to eliminate the presentation of theory, and merely cite and apply the formulas which it produced. But the close connection of theory and application has nevertheless brought into the body of the work much of the mathematical work of the theory, and as for the rest, Mr. Balet followed the lead of the Latin editor satirized by Byron, who first eliminates certain passages and "then adds them all in an appendix" for the sake of completeness.

The book is very hard reading. In dealing with a subject of so much inherent complexity, an author must exert most painful care, both in logic and in expression, if he would make it reasonably clear to the reader. Mr. Balet falls short of this. He knew his subject too well, perhaps, to exercise due care in maintaining that rigid logic of development and clearness of expression which the case demanded; and he was evidently handicapped by lack of practice in writing. Let the reader, then, not look forward to having an easy path through the wilderness of elastic arch analysis. For, even if he be not dismayed by the fact that every page abounds with algebraic formulas or the tracing of graphical processes, he will have many difficulties to face in the shape of over-abbreviated argument and proof, obscurity of expression, and lack of sequence. There are also occasional errors in the mathematics, as where (p. 259) the author is led by a piece of faulty integration to conclude that, for the two-hinged arch, "no temperature stresses can take place in the semi-circular arch." But if the reader is attentive enough to follow through the mathematical development at all, he will readily detect such lapses.

While the book professes to deal with *elastic* arches only, that is, statically indeterminate arches, yet it opens with the stress analysis of the three-hinged arch, which is statically determinate. The author has a neat graphical method which shortens and systematizes the graphical analysis of such structures quite materially (described by him in an article in Engineering News of Oct. 20, 1904, which article forms part of this chapter). Elastic methods, of course, do not enter into this chapter.

The two following chapters, occupying 134 pages, form the meat of the book; they deal with Two-hinged Arches and Hingeless Arches. The author's method for dealing with these structures may be stated quite simply: He has computed the "intersection locus" of the two-hinged arch and the "intersection locus" and "tangent curves" of the hingeless arch, in each case for an arch of parabolic axis, with moment of inertia of cross-section varying as the secant of the slope of the arch axis. For many arches these curves, which define the amount and location of the abutment thrusts for all positions of loading, may be used directly. They are given to scale and by numerical values of ordinates on p. 38 for the two-hinged arch, and for the hingeless arch on p. 104 for vertical loads and p. 121 for horizontal loads. When an arch has an outline departing materially from the parabolic form, the "standard" curves just referred to are to be corrected by certain methods devised by the author, which he describes in detail. When the rate of variation of the cross-section is different from that assumed for the standard, correction of the standard curves is less practicable. It is to be noted that two-hinged arches may depart most widely therefrom, as when they have a crescent-shaped outline. The author has, therefore, also calculated the curves for a "standard" crescent-shaped arch, which may be used for such cases (curves, on p. 77). Hingeless arches nearly always increase in thickness from crown to springlines, or else have constant depth of rib, and the "standard" curves may be applied to them with close accuracy. But a graphical method of determining the true intersection locus for the arch after its sections have been designed is also explained by application to specific examples, so that the reader is put in position to check the accuracy of the assumed loci in any individual case.

For the treatment of arch frameworks that cannot easily be approximated by arch ribs, as for example, the spandrel-braced arch, the author recommends using the Williot diagram to find the deformations under pure truss action, then calculating the thrust required to bring the change of span back to zero. The application of the method is explained by an example.

The author then interpolates a chapter entitled "Stresses in Arch Sections," which in the main is an exposition of the method of determining the extreme fiber stresses in a section when the longitudinal force is non-central. The chapter is continued, however, with the citation of a number of column formulas for steel, some paragraphs on reinforced-concrete columns, and a section on reinforced-concrete beams. In the latter, curiously enough, the author adopts a parabolic law of stress distribution in the concrete compression area, whereas in the first part of the chapter he assumes a straight-line law as preferable.

The last chapter, entitled "Stresses Caused by Lateral Wind Pressure," also deals with two separate subjects. Only four pages of the chapters discuss wind stresses, and this discussion is wholly unsatisfactory and incomplete; the hingeless arch, for example, is not mentioned, and the treatment of the two-hinged arch is neither full nor clear. The other 26 pages of the chapter contain a discussion of the relative advantages and disadvantages of the three types of arch, suggestions as to the loadings to be used, and hints on special points of the design, as proportioning the abutments, etc. A short table of steel and masonry arches is given at the close.

An appendix of 73 pages gives mathematical developments, containing the chief formulas used and referred to in the body of the book. It is divided into four sections, on the general formulas for the elastic arch, the two-hinged arch rib, the hingeless arch, and arched frameworks.

To those who do not shun the labor of working through a difficultly digestible presentation, this book affords an opportunity to make closer acquaintance with the elastic arch theory and its application than they have hitherto been able to derive from the American literature.

REINFORCED CONCRETE IN FACTORY CONSTRUCTION.—New York: The Atlas Portland Cement Co. Stiff paper; 6½ × 9 ins.; pp. 249; numerous text illustrations. Free to members of engineering and architectural professions, and to manufacturers; clothbound copies, 50 cts.

This book, which has been prepared for the Atlas Portland Cement Co. by Mr. Sanford E. Thompson, M. Am. Soc. C. E., is intended to demonstrate the efficiency of reinforced concrete for factory buildings, by description of many examples of successful constructions. It is in two parts. The first contains general instructions as to the design and construction of reinforced concrete buildings and is very little different from many similar books now in print. The second part consist of descriptions of nine different reinforced concrete factories, with detailed drawings fully explained in the text. In thoroughness of treatment and discrimination in selection this latter is excellent. The material therein presented is mostly new and in such shape as to be available for reference as to current practice.

THE GREAT RAILWAY FREIGHT-CAR PROBLEM AND ITS CHEAPEST AND BEST SOLUTION.—By H. W. Perry. Madras, British India: Lawrence Asylum Press. Boards: 6¼ × 8¼ ins.; pp. 101.

The gist of the author's proposal is contained in the following passages which we quote:

Every freight car comprises two different parts which have entirely different functions to perform. One part is the box or top which contains the freight that is carried, and the other part is the underframe and wheels that carry the box and its freight and run on the rails.

The latter part is rigidly confined to the track, and in all existing freight cars the first part or box is rigidly and inseparably connected to the under frame and wheels so that it also is absolutely confined to the track.

Hence it is necessary when loading or unloading a freight car to handle every individual article or package that forms its freight, and as this may amount to anything from 20 to 50 tons in weight, it is obvious a long time must be required for the process. And during all this time the frame and wheels are uselessly locked up standing idle, and about 50 ft. of most valuable track space in the freight house is blocked up.

Cannot this time be reduced? Of course, it can. The simple and obvious remedy is to make the top or freight-containing box completely separate and detachable from the frame and wheels, so that it can be quickly lifted or rolled off the latter, and be removed to any convenient place where it can be loaded or unloaded at leisure.

This comparatively slight and insignificant alteration is really the greatest economic improvement that can be effected in railways, and solves the great railway problem of the world.

The author's proposal is substantially to make all box cars platform cars and place four boxes on top, mounted on rollers, so that they could be quickly rolled off into a warehouse. The proposal is so radical that one naturally doubts its soundness. The author defends it, however, with much force and ingenuity.

While it seems very doubtful that the proposed innovation could prove any such panacea for

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railway ills as Mr. Perry claims, the idea appears to have real merit for special classes of traffic at least and the book deserves the attention of railway officials.

The Theory and Practice of Electric Traction.

Reviewed by HENRY H. NORRIS.*

ELECTRICAL TRACTION.—By Ernest Wilson, M. Inst. E. E., Professor of Electrical Engineering in the Siemens Laboratory, King's College, London, and Francis Lydall, Assoc. Inst. E. E. In two volumes. New York: Longmans, Green & Co. London, England: Edward Arnold. Cloth; 5½ × 8¾ ins. $4, net (each volume).

Vol. I.: Direct Current. Pp. 475; 271 illustrations, mostly in the text.

Vol. II.: Alternating Current. Pp. 328; 184 illustrations, mostly in the text.

It is a pleasure to examine a work prepared with the thoroughness which characterizes these two volumes. The theory and practice are interwoven in an instructive and attractive manner, and numerical examples, diagrams and pictures are freely used to illustrate the fundamental principles. The division into two volumes, one devoted to direct, the other to alternating current practice, indicates the rapid growth of the latter. This is especially true in Europe whence the authors derive their material upon this subject. The treatment throughout both volumes is direct and forceful, and no space is wasted upon unnecessary detail. At the same time, when a review of underlying theory will increase the value of the discussion it is given simply and concisely.

Vol. I. divides into two main parts, each of which is practically complete in itself. The first covers tramways, by which term is meant the light equipment used in ordinary surface traffic in cities. The other division is devoted to railways, both urban and interurban. As the rolling stock and track for these two classes of services are quite different, as are the conditions of operation, the division is a satisfactory one. After a brief introductory chapter on the general traction situation in England, the performance of a direct-current tramway motor is worked out numerically in order to indicate the nature of the problems involved. Then follow good descriptions of controllers and of the various details of car equipment. As typical of the method followed in general the paragraphs on starting resistance will serve as an illustration. In these the authors calculate, by a series of approximations, the resistance needed in a selected case to maintain the starting current within a definite range, with the corresponding rate of cutting out this resistance. Following the details of trolley poles and standards, bow collectors, circuit-breakers and lightning arresters, is a chapter on rolling stock. Detailed specifications of a car body and of an underframe are given and some space is devoted to trucks. In treating of brakes the authors seem partial to the magnetic type, which, judging from this fact, is more in favor abroad than in this country for tramway service. Tramway track and overhead equipment are discussed at length and in great detail, and many interesting and suggestive tables of design, construction and cost data are included.

In a lengthy chapter, several forms of slotted and surface contact systems are described. Such systems have found favor abroad, but with the exception of New York City and Washington, D. C., there are practically no installations of the kind in this country. The authors next take up the distribution system, the power station, car sheds and other important topics, each of which receives the same minute attention.

The second part of the first volume is much more important than the first part, as it contains studies of the problems of heavy and high-speed direct-current traction. The method of treatment is the same as in the first part, the railway motor and the accompanying apparatus being considered as the extension of the tramway equipment. Excellent dimensioned sectional views of several recent railway motors are given, and a few of the most important installations are described. The difficulties and tendencies of present practice are mentioned, and the authors display a broad perspective view of the situation. The control of heavy motors is shown to be a different problem from that of tramway motors and to illustrate this the latest multiple-unit control schemes are described in great detail. Similarly, such matters as getting the large currents into the cars, protecting the motors from overload, and braking safely and quickly, are not overlooked. Detail drawings of trucks and suspensions are given and a brief chapter is devoted to track and conductor rail construction. A very readable chapter is that in which problems on the mechanics of train movement are solved numerically for selected cases. After short chapters on feeders and direct-current substations the remainder of the first volume is taken up with miscellaneous cost data, and with the regulations of the Board of Trade, which to a great extent controls the installation of the track and the distribution systems of tramways and light railways in England.

The second volume of "Electrical Traction" will surprise many readers who have not realized the rapid and substantial progress made by the alternating-current motor abroad and at home. The authors have, on account of the scarcity of data on the design, construction and operation of the alternating-curent-motor, given much more detail than in the first volume. The polyphase induction motor is first treated. As this type develops practically constant speed, it has not found favor except in special cases, such as in mountain climbing, in the Berlin-Zössen high-speed test cars and to a limited extent in interurban service with few stops. The only case of its adoption in this country is on a mountain division of the Great Northern Railroad, soon to be electrified, where the constant speed characteristics of the induction motor are not objectionable. A complete analysis of the performance of the motor is given in the text, with vector diagrams of the electromotive forces and currents. The theory is illustrated by complete numerical calculations of typical motors. The actual detail dimensions of successful motors are given with dimensioned section drawings. Special attention is given to the practice of Ganz & Co., who have brought the polyphase system of railway operation to a high degree of perfection. The Italian State Railway, known as the Valtellina Railway, which is the most conspicuous example of high-speed, induction motor service, is amply described and illustrated both by diagrams and data. Three excellent chapters are allotted to control, to overhead construction and to energy consumption in polyphase systems. This practice appears to be well standardized and as applied to the class of work to which it is adapted few further improvements are to be expected.

The chief interest at present lies in another direction, namely, the development of the alternating-current, series motor. In this country, the New York, New Haven & Hartford and the Erie railroads have recently put into operation heavy locomotive and motor-car equipment, employing this motor. A number of light railways, such as the Central California Traction Co., the Indianapolis, Columbus & Southern, and others, have started alternating-current operation in the last year. The Pennsylvania Railroad is experimenting at present to determine the advisability of using this form of motor in the New York and Long Island terminal.

The authors begin the discussion of the single-phase motor by calling attention to the two types which are in commercial service, the series motor and the compensated repulsion motor. An outline of the theory of each type is followed by complete calculations for sample motors, leading up to the predetermination of performance curves. The structural details and performance of the series motor, with and without commutation poles, and the compensated repulsion motor are compared and several excellent illustrations are given. This chapter is the most concise, interesting and complete treatment of the subject at present available, and it is the most valuable part of the present work. The remainder of the volume contains chapters similar to those in the other sections, and of the same excellent quality.

From the analysis of this very complete work on electric railway engineering it is apparent that it is no ordinary book. It is, in fact, both a compendium of information and a logically-arranged treatise. It is in the same class with "Electric Railway Engineering,"* by Parshall and Hobart, although quite different in plan from that work. The fact that books of this type are possible proves that there is now a well-developed science of the subject. Electric railways, especially electrified steam railways, form the most absorbing topic in electrical engineering at this time. Whenever and wherever an author presents a practical or scientific paper on the subject, he has a large hearing. Good books have a most important function in conserving this interest and in furnishing a basis of information for it. This work will take its place as a standard reference text. It would in some ways make an excellent book for class use, but is rather expensive and too elaborate, except for highly specialized electric railway courses.

*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

DIE ASSANIERUNG VON KOEBENHAVN [Copenhagen].—Prepared by Messrs. Berg, Bjerre, St. Friis, Gredsted, Heiberg, Hertz, Hoff, Levison, Neergaard, Nielsen (K. M.), Nielsen (H. A.), Nohn, Oellgaard, Schierbeck, Tobiesen and Uirik, under the supervision of Dr. Th. Weyl. Part 14, Group II., Fortschritte der Ingenieurwissenschaften. Leipzig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 196; 108 illustrations in the text and 21 plates. 15 marks; American price, $6.

With the present volume, this series of useful monographs on the sanitation of important European cities now includes Paris (published in 1900), Vienna (1902), Zurich (1903), Cologne (1906) and Copenhagen (1907, the volume before us). The plan and scope of the earlier volumes are followed in this one (see this Supplement for Sept. 17, 1903, and Jan. 17, 1907, for notices of the monographs dealing with Zurich and Cologne, respectively). Under the editorship of Dr. Weyl, of the Royal Technical School of Berlin-Charlottenberg, local officials describe the works and activities under their charge. Besides water-works, sewerage and the collection and disposal of night soil, garbage, street dirt and other wastes, the volume before us deals with city planning, parks, streets, hospitals, bathing establishments, school hygiene, the sanitary supervision of the milk supply, and the disposal of the human dead. A concluding section deals with the cremation of the dead in Denmark. The make-up of the book is excellent.

*Reviewed in this Supplement, June 13, 1907, Vol. 57, p. 664.

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Electrical Handbook.

THE STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS.—Written and Compiled by a Staff of Specialists. New York: McGraw Publishing Co. Flexible leather; 4 × 7 ins.; pp. 1,283; illustrated. $4, net.

Somewhat of a departure seems to have been made in this volume from the common ideas of an engineering handbook. The familiar electrical and mechanical pocketbooks were evidently never intended to serve as miniature encyclopedias of basic principles already elucidated in numerous standard text-books, but were compiled with the modest intention of giving a useful collection of practical rules and data in compact form.

In this new handbook still another idea has been more strongly emphasized than in any previous pocket-book. The field of electrical engineering has been divided into 20 sections, each of which is treated in a unit section of the book. The preface states that each section has been written by a specialist in that branch, but inspection shows that ten of these sections were prepared in whole or in part by one person and that two others, on standardization rules and mathematical and statistical tables, have no sponsor.

The sections on electric and magnetic circuits, measurements, magnetic transformers, motors, water-power plants, power transmission and distribution, illumination, electric traction, electro-chemistry, telephony, telegraphy and on wiring have a considerable preponderance of theoretical discussion over practical data, although in several of these sections there are many data which seem very desirable in such a book. Such bits are the copper tables in the power transmission section, the various tables of electro-chemical data, dimensions of cars and locomotives and the costs of track and line constructions under the electric traction division. Data and description of current practice somewhat predominate over condensed theory in the sections on generators, batteries, steam and gas-driven plants, miscellaneous applications of electricity, standardization rules and of course in the mathematical and statistical tables.

It would seem that the library of any practicing electrical engineer should contain all the theoretical discussions which may be found in this book, and these, too, in nearly as convenient and in a more complete and satisfactory form. The peculiar needs of each individual engineer make it difficult to predict the usefulness of this volume, but it may reasonably be expected that the first edition will sell more readily on account of the novelty of its arrangement than because it "fills a long-felt want."

BRUECKEN IN EISENBETON.—A Text-book for School and Practice. By C. Kersten. Part II. Arch Bridges. Berlin, Germany: Wilhelm Ernst & Sohn. Paper; 6½ × 9¾ ins.; pp. 147; 356 illustrations in the text. 4 marks; American price, $1.60; or bound in cloth, 4.8 marks and $2, respectively.

The first part of this work on bridges of reinforced concrete, dealing with girder or beam bridges, appeared a year ago (reviewed in our issue of May 16, 1907, p. 552). In the present section, the subject is completed by the discussion of arch bridges. The treatment is almost wholly descriptive, and the text notes are supplemented by an abundance of drawings of the structures mentioned. There are some examples of computation and one or two chapters of more general discussion, dealing, for example, with the choice of outline, the use of hinges, etc. The main value of the book lies in its description of concrete arch bridges erected in various countries. The classification under which this matter is grouped does not impress us as very satisfactory, but this would not be a serious fault were it not for the absence of an index or even a detailed table of contents.

DAS PROBLEM DER PFAHLBELASTUNG.—By Ottokar Stern. Berlin, Germany: Wilhelm Ernst & Sohn. Paper; 6¾ × 10 ins.; pp. 198; 61 illustrations in the text and 6 plates.

The author studies pile resistance in a new way, by considering the displacement of the soil by the point of the pile and, if the pile be tapered, by its sides. He studies this action mathematically, using a "compression coefficient" determined by experiment with the soil. This study leads him to several general conclusions as to the relation between bearing capacity and pile taper and shape of point, and to formulas for calculating the bearing capacity from the shape and the soil coefficients. He then reviews the dynamic pile theory and compares the formulas of Eytelwein, Redtenbacher and Weisbach in a purely mathematical way.

STRENGTH OF MATERIALS.—A Manual for Students of Engineering. By William Charles Popplewell, Assoc. M. Inst. C. E., Lecturer on Strength of Materials, Theory of Structures and Hydraulics, at the Manchester Municipal School of Technology. Edinburgh and London: Oliver & Boyd. Cloth; 5½ × 9 ins.; pp. 180; 105 illustrations, mostly in the text. 5s., net; American price, $2, net.

When compared with the many excellent American textbooks on Applied Mechanics, this new English work engages attention only through its small size. Its text comprises only 166 pages, in which small space the author treats of the following wide range of subjects: Stresses in beams, deflection of beams, shear in beams, compression of short blocks and columns, shafts and springs, combined torsion and bending, strength of thin and thick tubes, and design of riveted joints. He also gives an introductory discussion of stress and strain, elaborates the graphical method for finding moments of inertia, discusses the chief phenomena of the ordinary tests of materials, and gives a chapter in which the more common materials of engineering are described. Manifestly, to handle such a large range of subjects in thorough fashion requires a treatise of respectable size. In the present work, therefore, we find only a very abbreviated treatment. Quite insufficient in breadth for the uses of the mature engineer, it can do good service as a first study test, for "the examination for the admission of Associate Members to the Institution of Civil Engineers, as well as the examinations in the Engineering Schools of the Universities," according to the preface. Had we no other texts in the same field, in our American literature, Prof. Popplewell's attempt might engage warm commendation. As matters stand, however, we already have a number of much better works, and there seems to be no place in the American field for this newcomer. To mention only one recent production, Slocum & Hancock's "Strength of Materials," is far and away superior, whether for reference, for school use or for individual study.

MOVING LOADS ON RAILWAY UNDERBRIDGES.—Including Diagrams of Bending Moments and Shearing Forces and Tables of Equivalent Uniform Live Loads. By Harry Bamford, Assoc. M. Inst. C. E., Lecturer on Engineering Drawing and Design, Glasgow University. London, England: Whittaker & Co. (New York: The Macmillan Co.) Flexible cloth; 6½ × 8¼ ins.; pp. 78; 80 figures in the text. $1.25, net.

"Railway Underbridges" seems to mean simply "railway bridges," although it may perhaps be intended to mean "railway deck bridges." "Moving loads" is used in the sense of "wheel loads." The book gives a demonstration of graphical and analytical methods for finding maximum moments and shears under any given system of wheel loads. Methods for girders or solid beams only are discussed, and nothing is said of the modifications introduced by the paneling in truss bridges. Altogether the book contains nothing that is either radically new or not available to American readers.

Incidentally we may remark that "co-planer" is a poor way of spelling co-planar, and that "the algebraic sum of the moments is nil" is a poor way of saying that it is equal to zero. The word "nil" is about due for the scrap-heap—a statement which addresses itself as much to American as to English authors.

PLANE AND SPHERICAL TRIGONOMETRY.—By A. H. Buchanan, LL.D., Professor of Mathematics, Cumberland University. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 96; 30 figures in the text. $1, net.

The merits of this Trigonometry are: A very concise style, novel and simple demonstrations, and very direct paths from one phase of the subject to the next. The text engages the student's close thought at every step, and notwithstanding

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the unavoidable "heaviness" of all mathematical expositions, its qualities make it seem quite refreshing in comparison with the dead chains of unenlightening formulas that constitute some Trigonometries we have met. The work is excellent, and deserves a wide field of use. It is so compact as to be perhaps a difficult book for self study; but whoever has once gone through a course in trigonometry will find it an easy and very helpful text for reviewing the subject.

A Novel Treatment of Elementary Electrical Engineering.

AN INTRODUCTION TO THE STUDY OF ELECTRICAL ENGINEERING.—By Henry H. Norris, M. Am. Inst. E. E., Professor of Electrical Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 404; 179 illustrations, mostly in the text. $2.50, net.

In the study of electrical engineering, which is "the application of magnetic and electrical principles," the author says that

> it is especially important that the student in approaching the subject should have personal knowledge of the *things* and *phenomena* before any *reasons* can be ascribed to them.

The fundamental idea of Prof. Norris' new book is an application of this idea. Not only is the book as a whole planned to be a means for imparting a general knowledge of machinery, appliances, electric plants, etc., before the theory of action of these things is examined in subsequent study, but also the arrangement of the book itself is dictated by the same idea. The view expressed by the quotation is unquestionably sound; the question will be as to whether it has been applied fruitfully.

The main contents of the book comprise eight chapters, covering the following subjects: Construction of Electric Generators (30 pp.), Operation of Electric Generators (17 pp.), Transformers and Their Application (22 pp.), Construction and Operation of Power Stations (46 pp.), Electric Motors and Their Applications (40 pp.), Electric Lighting and Heating (27 pp.), Electric Measurements (22 pp.), and The Transmission of Intelligence (22 pp.). All this matter is purely descriptive, with, of course, explanation in general terms of the interrelation of parts, etc. The space available with the large type used is, of course, not sufficient to give opportunity for great detail. Two chapters immediately preceding these, dealing with Electric Circuits (wiring and wire lines), and Magnetic Circuits, belong with the descriptive part of the book, in so far as they describe construction. More broadly, however, they form part of the preparatory matter. Incidentally, these two chapters explain the elementary calculations by which wiring and magnetic circuits are proportioned.

Besides the two chapters mentioned, three preparatory chapters and an equally important introduction make up the first part of the book. The introduction evidently is intended to do the first rough work in recalling to the student's mind the chief manifestations of electrical application (with most of which his daily life has made him familiar), and grouping them in a systematic relationship. This completed, the author stops to give a very condensed sketch of electrical history, up to the advent of the trolley-car, introducing the names of the principal men who made the history. Two chapters of quite different character follow. The first deals with Fundamental Electrical and Magnetic Quantities, in which the units by which we measure electrical phenomena are formally defined, and their utilization is illustrated by numerical problems. The other preparatory chapter is a well-written descriptive account of Materials of Electrical Engineering.

The descriptive character is maintained consistently, except by the chapter on Fundamental Quantities. It may well be argued that the student is not ready to be told how a power-station is arranged and how transformers are used until he has obtained clear conceptions of current, power, inductance, resistance, etc., and of their quantitative relations. The question then arises whether the author has solved the difficult problem of imparting these conceptions. As far as inductance and capacity are concerned, he does little more than give their formal definitions; still he is to be commended for introducing them at all. These quantities are usually suppressed until after the student has gone through his whole direct-current course, with the unfortunate result often that he considers them as peculiar to alternating current, and probably connected in some obscure but intimate way with a pure sine wave. To establish conceptions of current, electromotive force and resistance, however, Prof. Norris has recourse to some awkward experiments with a Faraday disk. We seriously doubt whether these will prove sufficient for the purpose intended. A much fuller and more painstaking illustration of electric and electromagnetic actions would have been worth while.

It is desirable that a work following a radically new plan of presenting a subject, as this one, should not be handicapped by deficiencies in style. The present book, however, suffers seriously through a looseness and inaccuracy of expression, especially in the earlier preparatory chapters, that is often surprising. The definition or statement of "incandescence" and "luminescence," p. 5, is an early example of this, and is worth quoting in full:

> Incandescence is due to the high temperature of the substance, and the intensity has a definite and well-known relation to the temperature without regard to the substance heated.
>
> Luminescence, sometimes called "cold light," while depending somewhat upon the temperature, also involves a property possessed by some materials of generating light waves in greater quantity than can be accounted for by incandescence. This process is frequently named selective radiation.

And just beyond this, the author gives the Welsbach mantle as an illustration. This, he says, "when heated to a moderate temperature *gives off light efficiently.*" In the same part of the subject he produces multiple confusion in describing the arc lamp. A cut shows an enclosed arc lamp, whose carbons are ordinarily separated ½ to 1 in., but the text, without mentioning open or enclosed arcs, says that the carbon points are separated ⅛ to ⅝ in. It also states that the current "heats the carbon tips *or craters,*" though so far as we know the direct-current arc has but one crater, while the alternating arc has none at all. Fortunately, these statements about arc lamps may soon be forgotten by the student. Even so, the half page cut showing the electric circuits of an arc lamp is wasted at this stage of the book.

It is similar looseness or superficiality of expression, perhaps, that makes the author say (p. 46) that Frank J. Sprague "became interested in electric railway work and devised a number of new features." In place of this vague and uninforming statement, a direct statement would probably have taken a little more space.

Lack of precision of expression (and thought) is also chargeable with some of the poor effect of the experimental explanation of fundamental quantities in Chap. II. Here "rotative force" and "mechanical force" are spoken of in a loose way. The obvious necessity of mentioning that the force required to turn the Faraday disk is greater when the circuit is closed than when the circuit is open seems to have been left out of mind. Throughout this section, in fact, the reasoning, or its expression, is so obscure that, when the conclusion is drawn that power is the product of the square of the current and the resistance, the reader can do nothing more than accept the statement in blind wonder.

These few instances of what appears to us seriously defective style are hardly adequate to represent the defect. Much of the looseness is spread through the whole course of paragraphs in such uniform distribution that we would have to cite passages entire to exhibit the result. It is quite possible that under the direction of a capable instructor the injurious possibilities hereof would be neutralized. But the home-study reader will unquestionably be much puzzled and misled before he has safely navigated past the preparatory chapters of the book and has reached the smoother waters of the main descriptive section.

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MANUAL OF RECOMMENDED PRACTICE FOR RAILWAY ENGINEERING AND MAINTENANCE OF WAY.—American Railway Engineering and Maintenance of Way Association, 962 Monadnock Block, Chicago. Cloth; 6 × 9 ins.; pp. 291; illustrated. $3. (Half morocco, $3.50).

This is the latest edition of the "Manual," containing the most recent definitions, specifications and principles of practice adopted and recommended by the association. The book is in the main a compilation of the conclusions which are presented with the annual reports of the several working committees, and adopted (with or without amendment) by the association. The subjects are arranged under the headings of the committees, and some include matters relating to construction, track, buildings and bridges. Signaling, water softenings, and the design of railway yards are among the subjects, and there

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are a number of standard forms for records of tie renewals, bridge inspections, estimates of cost, right-of-way property, etc. The reports on signaling and records include standard conventional signs for drawings. A considerable proportion of the book is occupied by detailed specifications, which include the following subjects: Grading, steel bridges, timber bridges and trestles, tie preservation, rails, cement, concrete, fencing and interlocking plants.

Baths and Bath Houses.

MODERN BATHS AND BATH HOUSES.—By William Paul Gerhard, C. E. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 311; 130 illustrations in the text. $3, net.

The increasing interest in the subject of municipal public baths, and the great need of adding to the relatively small number of such institutions in the United States, combine to make opportune a good book on the subject. The volume before us is by no means confined to municipal baths, nor for that matter to water baths, but is a comprehensive treatment of water baths for private dwellings, municipalities, schools, factories, military barracks, prisons, hospitals, clubhouses, etc. The classes of baths named are, of course, indoor establishments. In addition there is a chapter on river and sea baths. Besides water baths, the author treats in considerable detail of air and sun baths, and medical and electric-light baths.

The author, being strongly in favor of rain baths, especially for municipal and institutional use, and having taken an important part in introducing that type of baths to this country, naturally devotes considerable space to the subject. Details of the mixing and spraying apparatus for rain baths are given, and the volume also contains some other drawings of bath fixtures. The illustrations include, in addition, a goodly number of plans of municipal and other bathing establishments and a still larger number of half-tone views of all sorts of baths and bath houses.

The bibliography on baths and bathing will be useful to those who wish to pursue the subject further. An appendix contains a number of interesting extracts from the writings of various persons on bathing, as practised in Russia, Norway, Finland and Japan. The appendix also contains a few pages on baths for dogs.

Altogether the book is a very useful addition to the literature of sanitation and of social welfare. It contains more repetitions than are pleasant to a person who reads the book from beginning to end, but to those who use it for purposes of looking up a single type of baths these repetitions will, of course, not be troublesome, and in fact will save turning to other parts of the book.

The book is based in no small part on recent investigations by the author in Europe and on his own practice as sanitary engineer, during which he has installed a considerable number of baths for hospitals and other institutions. It is a far more comprehensive work than "Public Baths and Wash-Houses," by Alfred W. S. Cross, reviewed in this Supplement for March 14, 1907. Reference may be made, in passing, to a small book on "Swimming Pools," by John K. Allen, reviewed in these columns for July 18, 1907.

Mention should be made, before concluding, of the fact that the book contains specifications for a municipal bath house (16 pp.).

MINING SCIENCE.—A Weekly Journal Devoted to Mining, Metallurgy and Engineering. Being a Consolidation of "Mining Reporter" and "Ores and Metals." Vol. LVI., No. 24, Dec. 12, 1907. Denver, Colo.: The Mining Science Publishing Co. (1725 Arapahoe St.). Paper; 9 × 12¼ ins.; pp. 533 to 572; illustrated. $3 per year; single copies, 10 cts.

By the consolidation of the "Mining Reporter" and "Ores and Metals," this new journal, "Mining Science" has resulted with Mr. G. J. Bancroft, M. Am. Inst. M. E., as Editor. The first number is designated as No. 24, Vol. LVI., having taken the numerical succession of the "Mining Reporter." In the first number there are 12 pages of original matter on mining topics, 13 pages of reprinted articles, 6 pages of reports from mining districts, 3 pages of trade notes, 3 pages of mining and allied statistics and a 3-page index of current mining literature.

WORK DONE.—No. 3. New York: Westinghouse, Church, Kerr & Co., Engineers. Stiff paper; 6 × 9 ins.; pp. 137; folding plates and text illustrations.

While this volume may be called a "trade publication," yet the subject matter seems to be of sufficient interest and the appearance of the work pleasing enough to command far more attention than is ordinarily accorded a trade publication. The book contains descriptions of the engineering work designed and executed by the Westinghouse, Church, Kerr & Co. in installing electric traction on the western lines of the Long Island R. R., as a part of the Pennsylvania R. R. terminal improvements in and about New York City. The text is divided into four sections treating: (1), the Long Island City power station; (2), the power transmission line and third-rail system of the Long Island R. R.; (3), the rotary converter sub-stations; (4), the electric car equipment.

ELECTROCRAFT.—Illustrated List of Approved Electrical Fittings and Revised National Electrical Code. Detroit, Mich.: Electrocraft Publishing Co. Stiff paper; 5¼ × 7¾ ins.; pp. 389; illustrated. 50 cts.

To those who have to specify fittings for the more common electric service installations, such as lighting, heating and supplying small amounts of motive power, the first edition of this book proved of great assistance, since it brought into small compass, in handy and accessible form, a list of all fittings that had been examined, and approved by the Underwriters' National Electric Association. Only fittings so examined and approved can be used in a building which is to be insured so that it is of paramount importance to readily determine what makes of apparatus are or are not satisfactory to the underwriters' association. With the work of examination and approval constantly going on it is obvious that the list must change quite rapidly and a new edition of this publication became advisable. So rapid has been the change in the list of approved fittings that it has been judged feasible to publish this book quarterly and it will hereafter appear in January, April, July and October. Each approved fitting is illustrated, described, with its catalog number, and the name of the maker plainly indicated. The 1907 "National Electric Code" for the installation of electric wiring and apparatus is appended.

NOTES SUR LE COMMERCE INTERNATIONAL, LA NAVIGATION ET LES FINANCES DU BRESIL.—[Brazilian Commerce.]—By Dr. V. Souto, Professor of Political Economy and Finances at the Polytechnic School of Rio de Janeiro. Extract from "O Brasil, suas Riquezas Naturaes, suas Industrias." Paper; 7 × 11 ins.; pp. 92; with 3 colored plates and many tables. Rio de Janeiro: M. Orosco & Co.

Mainly statistical, the development of the wealth of Brazil and its present condition being exhibited in the text and in tables.

THE EXAMINATION OF PLANS FOR STATE BUILDINGS.—Public Health, Michigan, October-December, 1907 (Special). Lansing, Mich.: State Department of Health (Frank W. Shumway, Secretary). Paper; 6 × 9 ins.; pp. 14.

Notes on undesirable features in the design of public buildings disallowed by the State Board of Health in approving plans, are here given.

CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1906.—Part II. Coal, Lignite, and Peat. Marius R. Campbell, Geologist in Charge. Bulletin No. 316, U. S. Geological Survey. George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 543; 23 plates and 6 text illustrations.

These "Contributions" consist of 24 papers on the geological formation of numerous little-known coal deposits in Pennsylvania, Kentucky, Virginia, Alabama, Illinois Arkansas, Montana, Wyoming, Colorado, Utah, New Mexico and California. There is an introduction, by the geologist in charge, summing up the scope of the papers. Appended to the geological papers are three general ones on the status of producer-gas plants, on the coal briquetting industry and on uniform mine sampling. There is also a classified list of papers of the Geological Survey on coal, coke, lignite and peat.

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More Documentary Evidence Against Municipal and State Ownership in Great Britain.

THE BRITISH STATE TELEGRAPHS.—A Study of the Problem of a Large Body of Civil Servants in a Democracy. By Hugo Richard Meyer, Author of "Government Regulation of Railway Rates," etc. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5¼ × 8 ins.; pp. 408. $1.50, net.

PUBLIC OWNERSHIP AND THE TELEPHONE IN GREAT BRITAIN.—Restriction of the Industry by the State and the Municipalities. By Hugo Richard Meyer, Author of "Government Regulation of Railway Rates," etc. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5¼ × 8 ins.; pp. 386. $1.50, net.

Books against municipal and state ownership of public utilities are multiplying rapidly. Professor Meyer alone has written three in the last two years: The first, noticed in this Supplement for Aug. 16, 1906, dealt with the general subject of "Municipal Ownership in Great Britain." The two now before us treat of the telegraph and the telephone, with much in addition about the British Post Office, which owns the telegraph and at the close of 1911 will complete its partial ownership of the telephone service. The other recent literary opponents of municipal and state ownership have also directed their pens against Great Britain: Mr. Robert Porter in "The Dangers of Municipal Ownership" and Lord Avebury (Sir John Lubbock) in "National and Municipal Trading," both reviewed in our issue of May 16, 1907.

Professor Meyer's book on the Telegraphs is chiefly concerned with "the problem of a large body of civil servants in a democracy," as illustrated by the employees of the British Post Office in general and those in the telegraph department in particular. His main thesis is that state telegraphs have failed to pay expenses because wages and other conditions of service have been dictated by the employees and their friends, instead of by business considerations, and that this has been made possible by the meddling of Parliament and its individual members with the administrative officers of the Post Office.

Besides his main thesis, Professor Meyer aims to prove: That there was no real ground for the public acquisition of the telegraphs; that the readjustment in rates that followed, and which was in large part the object of state ownership, was ill advised; that the great increase in telegraph business consequent on the reduction of rates rendered the telegraphs non-self-supporting, although this might have been overcome, as already stated, had the Post Office employees and Parliament not run away with the former; and that, in general, the great British public is so lacking in appreciation of the proper basis for conducting public business and so much in sympathy with public employees that nothing short of mismanagement, poor service and excessive cost can be expected whenever the state or a municipality undertakes any service which a private company is willing to conduct. The obvious moral urged by the author is that other countries, as well as Great Britain, should abstain from municipal and state ownership.

The book on the Telephone deals more directly than does the one on the Telegraphs with the specific questions of public ownership. Its burden, however, is chiefly that the Post Office on the one hand and the municipalities on the other have throttled the telephone industry and service in Great Britain; that this was done, in the first instance, because the Post Office feared that the telephone would injure its telegraphs, and, later, because the municipalities and the Post Office together, and finally the Post Office alone, wished to control the whole telephone service. The municipal and Post Office telephone services are described, and as much discredit is thrown upon both as is possible in the space available. For the ensuing four years, or until the Post Office takes over the property of the National Telephone Co., at the close of 1911, Professor Meyer predicts a continuation of the present service, which he pictures as far inferior to that of the United States.

These two books by Professor Meyer, like the one that preceded them, may be briefly characterized as ably written, extremely partisan briefs against municipal ownership, based almost wholly on printed documents, the latter being principally Hansard's Parliamentary Debates and various committee reports. A large percentage of the space is occupied by quotations from the documents indicated, some of which are repeated at least three times, in different chapters. Twice there appears a quotation to the effect that, owing to the lowness of the rates, the telegraphs had been used to send for a clean handkerchief. Although the documents cited must abound with arguments in support of public ownership, practically none of these are ever so much as hinted at, except for refutation or ridicule.

Such one-sided books have some grounds for their justification, but they do not make for truth, and when so extreme as these are it is questionable whether, in the long run, they do their own side more good than harm. It would be interesting to see what could be done on the other side of this vexed question if as able a partisan as Professor Meyer made similar use of the same documentary sources, but an impartial study of the documents would be more helpful.

Notwithstanding the partisan character of these two books, and the limitations due to their being composed almost wholly of quotations from or abstracts of parliamentary reports, with little explanation of foreign practices that are liable to mislead the uninformed, we commend the books to all those interested in either side of the public ownership question. The books are particularly valuable because, although overdrawn, they present so striking a picture of some of the dangers besetting municipal ownership, and particularly the dangers incident to the employment by the city or state of large bodies of wage-earners.

STRUCTURAL DRAWING.—By C. Franklin Edminster, Instructor in Department of Fine and Applied Arts, Pratt Institute, Brooklyn, N. Y. Published by the Author. ("Supplied" by David Williams Co., New York.) Cloth; 8¾ × 7¼ ins.; pp. 148; 74 illustrations, mostly in the text. $2.50.

Among the many text-books on drafting and lettering there have been few that treat exclusively the correct representation of structural details as does this book by Mr. Edminster. With the exception of a few preliminary pages on geometrical drawing, it is devoted to the standard connections in structural steel and iron work. As a portfolio of plates supplementary to oral instruction the book may have some value to a beginner, but the paucity of explanatory text deprives the drawings of much of their usefulness. The drawings themselves would be clearer if they had been drawn with a view to reproduction. The loss in tone and contrast by the necessary reduction should have been compensated for in the originals.

GENERAL SPECIFICATIONS FOR CONCRETE WORK.—As Applied to Building Construction. By Wilbur J. Watson, Consulting Engineer. (Address The Author, Citizens' Building, Cleveland, O.) Stiff paper; 6¾ × 9½ ins.; pp. 46.

It is not necessary to emphasize the fact that a rigid specification, reasonably enforced by the inspector, is the safeguard of concrete construction. Such a specification has never been adopted by any authoritative body, as has been done in other modes of construction, because the methods of designing and handling the material have not yet become sufficiently standardized to warrant such action. However, many cities have passed regulations for concrete work which, in city buildings, take the place of the specifications. It is on the line of these regulations that Mr. Watson's specifications are modeled, taking in, however, a somewhat broader field than any city regulations heretofore adopted. As in all such specifications the individual user must cut and fill to suit local needs, but as a basis on which to make either city regulations or contractors' specifications the pamphlet should be of great assistance. It might be remarked that some of the unit values are higher than are usually used. For instance, the author gives 156 lbs. as the weight of 1 cu. ft. of a 1:2:4 stone or gravel concrete. It would take a very hard, compact stone to give so heavy a concrete. Again, in the permissible unit stresses for concrete in flexural compression the values are given as: stone concrete, 750 lbs. per sq. in.; slag concrete, 650 lbs. per sq. in.; cinder concrete, 400 lbs. per sq. in. While these values are safe they are considerably higher than conservative practice allows.

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A STUDY OF ROOF TRUSSES.—By N. Clifford Ricker. Bulletin No. 16, University of Illinois Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6 × 9 ins.; pp. 28; 14 illustrations in the text.

In the preliminary investigation and design of a roof truss a certain dead load must be assumed as a basis for computation. Numerous formulas have been devised which give such a load, assuming the material and dimensions of the truss. The various formulas are extremely diverse in their results and no one is authoritative, so Mr. Ricker, who is Professor of Architecture in the University of Illinois, set out to determine a new formula, which would be simple and at the same time more accurate than the old ones. In this determination a great number of trusses varying in span, rise and material were computed, and with their weights as a basis the following extremely simple formula was devised:

$$w = \frac{S}{25} + \frac{S^2}{6{,}000}$$

where S = span in feet and w = weight of truss in lbs. per sq. ft. of horizontal projection of roof.

In connection with the study many other details of roof truss design were looked into, such as the comparison of formulas for normal wind pressure, comparative weights of trusses of various materials, economical distance between trusses, economical length of panels, economical number of purlins per panel, advantage of cambering lower chord and the economical ratio of rise to span.

THE CONTROL OF STREET OPENINGS.—A Discussion Concerning an Ultimate Remedy for the Destruction of City Pavements by Openings. New York: The Independent Asphalt Association (90 West St.). Paper; 6 × 9 ins.; pp. 29; illustrated. Gratis on application.

This is a compilation of information on the damaging effect of street openings on pavements, gleaned from books and printed reports and from correspondence with city officials.

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Laboratory Physics.

PRACTICAL PHYSICS.—A Laboratory Manual for Colleges and Technical Schools. By W. S. Franklin, C. M. Crawford and Barry MacNutt. In three volumes. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5½ × 8¼ ins. Vols. I. and II., $1.25 net, each; Vol. III., 90 cts., net.
Vol. I.: Precise Measurements.—Measurements in Mechanics and Heat. Pp. 173; 75 illustrations in the text.
Vol. II.: Elementary and Advanced Measurements in Electricity and Magnetism. Pp. 160; 71 illustrations in the text.
Vol. III.: Photometry. Experiments in Light and Sound. Pp. 77; 49 illustrations in the text.

The numerous excellent manuals for the physical laboratory which are now available have a worthy addition to their number in "Practical Physics." The three volumes before us give a well-chosen course of experiments and tests, presented and explained in a clear and precise fashion and prefaced by a short but very helpful discussion of procedures in observing, recording and computing. The work has no further purpose, of course, than to direct and assist the college student (and his instructor). Its efficiency in any individual case must therefore be dependent on the correspondence between the time and equipment available and that required by the course of experiments here laid down. The general student does not ordinarily devote so much time to physical laboratory work as is here contemplated, we imagine. Yet the book is flexible in its application because a large number of the experiments may be omitted without affecting subsequent ones.

Vol. I. gives 24 experiments dealing with the measurement of length, angle, weight and time, followed by 24 so-called "experiments in Mechanics," which include such diversified things as Study of a tackle block, Measuring the shear modulus by torsion, Measurement of surface tension of water, Study of the Venturi water meter, etc. The volume is closed by 13 experiments in Heat. The introductory chapter of this volume gives the discussion of experimental procedure which has already been referred to.

Vol. II. is exclusively electrical. It opens with 19 "simple experiments" in electricity and magnetism, which, however, go far enough to include the determination of the horizontal component of the earth's field, a study of the residual charge of a condenser, measurement of dielectric strength by a spark gage, etc. The "advanced measurements" which make up the rest of the volume, 28 in number, include such problems as the comparison of resistance standards, magnetic tests, comparison of inductances and capacities, determination of migration velocities, and an experiment in radio-activity.

Vol. III. deals with Photometry, and Light and Sound. It gives 5 photometrical experiments, 16 in light and 3 in sound. The last are hardly of equal rank with those given in the rest of the work, but are possibly the best that can be handled by students in the college laboratory.

The style of the work, both literary and typographical, is excellent.

TABLES OF THE PROPERTIES OF STEAM AND OTHER VAPORS.—And Temperature-Entropy Table. By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. Seventh Edition, rewritten. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 131. $1.

To anyone having to do with boiler testing, Peabody's Tables have been a reliable assistant since the issue of the first edition in 1888. A comparison of the first edition and this last one, the seventh, indicates some of the interesting developments in steam engineering during this period. The additions and changes show the results of later experiments, the use of the temperature-entropy relations and, indirectly, the increasing importance of superheated steam.

To facilitate adiabatic-expansion computations, which have become prominent since the rise of the steam turbine, a temperature-entropy table has been prepared giving the quality, heat content and specific volume of moist and superheated steam for each degree Fahrenheit, and for each hundredth unit of entropy. It would seem, in view of present tendencies of steam-engineering practice, that a well executed temperature-entropy table would to-day be as welcome as the saturated-steam tables were twenty years ago.

While the greater part of the volume is given over to the saturated-steam and temperature-entropy tables, the familiar short tables of the properties of saturated vapors of ether, alcohol, chloroform, carbon bisulphide, carbon tetrachloride, aceton, ammonia and sulphur dioxide are retained. The extended introduction to the tables explain the terms and units employed and the use of the tables.

BULLETINS, U. S. GEOLOGICAL SURVEY.—George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.
No. 316 (Extract): General Papers on the Producer-Gas Power Plant, the Coal-Briquetting Industry and Coal-Mine Sampling. With a Bibliography of Geological Survey Publications on Coal, Lignite, and Peat. By R. H. Fernald, E. W. Parker, J. S. Burrows, W. T. Lee and J. M. Nickles. Pp. 439 to 532; one illustration in the text.
No. 334: The Burning of Coal without Smoke in Boiler Plants. A Preliminary Report. By D. T. Randall. Pp. 26.
No. 339: The Purchase of Coal under Government and Commercial Specifications on the Basis of Its Heating Value. With Analyses of Coal Delivered under Government Contracts. By D. T. Randall. Pp. 27.

There are three general papers included in the "Extract" from Bulletin 316: (1) "The Present Status of the Producer-Gas Power Plant in the United States"; (2) "The Condition of the Coal-Briquetting Industry in the United States"; (3) "The Importance of Uniform and Systematic Coal-Mine Sampling." The first paper treats of the rapid development of the gas producer and gas engine, shows the general results of tests made at the fuel testing plant at St. Louis, on coals from various States, and epitomizes the opinions of makers, owners and users of producer-gas power-plant apparatus. The second paper presents a list of concerns supposed to be engaged in the briquetting of fuels as gathered from newspapers, etc., and gives such detailed information about those plants that are active as investigation brought out. The third paper treats of the inaccuracies induced in coal analyses by variation in sampling methods, and suggests remedies.

Bulletin No. 334 seems to aim to place the subject of smoke prevention and complete combustion of fuel in such form that it can be understood by non-technical readers. It would be a good pamphlet to place in the hands of every intelligent fireman in a plant burning soft coal. The ordinances against smoking chimneys, in the various large cities of this country; the causes of smoke production; the means of its prevention; the securing of more perfect combustion under boilers; all these are briefly presented. At the end of the bulletin is a bibliography on coal and combustion.

Bulletin 339 treats the right and the wrong methods of buying coal in more than household amounts. The specifications under which most of the government fuel contracts are let are given in full, and there are extracts from several commercial specifications used in various places. In general, such specifications fix the maximum amounts of ash, sulphur, dust and fine coal and volatile matter allowable, and require that payment be based on a certain determined normal ash content and heating value, and that premiums and deductions are to be made for departures above or below this standard.

INVESTIGATION OF CENTRIFUGAL PUMPS.—Part I.: A Discussion of the Theory of the Centrifugal Pump and Tests of a Six-Inch Vertical Centrifugal Pump. By Clinton Brown Stewart, C. E. Bulletin of the University of Wisconsin, No. 173; Engineering Series, Vol. 3, No. 6. Madison, Wis.: The University. Paper; 6 × 9¼ ins.; pp. 447 to 588; 30 illustrations, partly in the text, and 28 tables. 50 cts.

The department of hydraulic engineering of the University of Wisconsin is conducting an extended line of experiments on centrifugal pumping machinery, with the view of deriving data on actions which have been considered rather complicated and obscured by unknown factors. The first bulletin on the subject, entitled "Investigations of Centrifugal Pumps. Part I.—A Discussion of the Theory of the Centrifugal Pump and Tests of a 6-in. Vertical Centrifugal Pump," discusses the general theory as ordinarily given for deriving the theoretical head developed by the impeller, and shows experiments with a 6-in. vertical centrifugal pump arranged specially to investigate the effect, on the discharge and efficiency, of the number and shape of the vanes of the impeller. A comparison of the results of the experiments shows the effect on discharge and efficiency of the pump of practically all possib'e modifications of the simple radial vane.

NILE RESERVOIRS AND THE COTTON CROP.—By Sir William Willcocks, K. C. M. G., F. R. G. S. A Lecture Delivered at a Meeting of the Khedivial Geographical Society on Dec. 21, 1907. Cairo, Egypt: Pub. Doc. Paper; 7¼ × 10½ ins.; pp. 20.

The author, who has for some time been an able and persistent advocate of the storage of Nile waters for irrigation use in Egypt, here recounts briefly his observations on a recent trip to the upper waters of the Nile, and continues his advocacy for storage, particularly on the White Nile. It is interesting to note that in introducing the subject the author stated that he was engaged on the preparation of the third edition of his work on Egyptian irrigation.

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Prehistoric Water Supply.

NEOLITHIC DEW-PONDS AND CATTLE-WAYS.—By Arthur John Hubbard, M. D., and George Hubbard, F.S.A., F.R.I.B.A. Second Edition. London and New York: Longmans, Green & Co. Cloth; 6¾ × 10 ins.; pp. xxiv. + 116; 29 illustrations, partly in the text. $1.20, net.

For the benefit of such of our readers as do not happen to know just what a neolithic dew-pond is, we quote from this interesting book as follows:

We are not aware that the thermodynamics of a dew-pond have ever been elucidated, and it is evident that this cannot be done until the construction of such a pond is understood. There is still in this country at least one wandering gang of men (analogous to the medieval bands of bell-founders, masons, etc.) who will construct for the modern farmer a pond which, in any suitable situation in a sufficiently dry soil, will always contain water. This water is not derived from springs or rainfall, and is speedily lost if even the smallest rivulet is allowed to flow into the pond. The gang of dew-pond makers commence operations by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. They then thickly cover the whole of the hollow with a coating of dry straw. The straw in its turn is covered by a layer of well-chosen, finely puddled clay, and the upper surface of the clay is then closely strewn with stones. Care has to be taken that the margin of the straw is effectively protected by clay. The pond will gradually become filled with water, the more rapidly the larger it is, even though no rain may fall. If such a structure is situated on the summit of a down, during the warmth of a summer day the earth will have stored a considerable amount of heat, while the pond, protected from this heat by the non-conductivity of the straw, is at the same time chilled by the process of evaporation from the puddled clay. The consequence is that during the night the moisture of the comparatively warm air is condensed on the surface of the cold clay. As the condensation during the night is in excess of the evaporation during the day, the pond becomes, night by night, gradually filled. Theoretically, we may observe that during the day the air being comparatively charged with moisture, evaporation is necessarily less than the precipitation during the night. In practice it is found that the pond will constantly yield a supply of the purest water.

The dew-pond will cease to attract the dew if the layer of straw should get wet, as it then becomes of the same temperature as the surrounding earth, and ceases to act as a non-conductor of heat. This, practically, always occurs if a spring is allowed to flow into the pond, or if the layer of clay technically called the "crust") is pierced.

A number of such ponds are described in the volume before us, in connection with prehistoric earthworks. The cattle-ways mentioned in the title were usually associated with the same class of earthworks; and to a large extent both the dew-ponds and cattle-ways were incidental to a time when man had to guard himself carefully against animal as well as human foes, and on that account found it desirable to live on elevated lands easily defended against attack. Since many of these earthworks were located on the chalk, the only method of near-by water supply available would, the authors state, be the ponds described. The cattle-ways, however, often led to streams at greater or less distances from the fortified camps.

A COMPILATION OF THE RECORDS OF THE COLORADO SPRINGS LIGHTING CONTROVERSY.—With an Introduction and Epitome. By Henry Floy, M. Am. Inst. E. E., etc., Consulting Engineer. New York: Illuminating Engineering Publishing Co. Cloth; 6 × 9½ ins.; pp. 327; plates and diagrams. $4, net.

This volume makes readily accessible, in authentic form, the details of one of those controversies where arbitration has taken the place of ordinary judicial action and where the final settlement, through the arbitrators' award, has been based on the apparent merits of both sides of the case. The award was printed, in slightly abbreviated form, in Engineering News, May 2, 1907, and may be briefly reviewed here as definately answering several questions: (1) Does the term "2,000-c.p. arc lamp" designate an illuminant which can develop light of 2,000 candle power? (2) Did the lamps furnished for the city of Colorado Springs come under the generally accepted meaning of the term "2,000-c.p. arc lamp"? (3) If not, what was the amount of overcharge made by the Pike's Peak Hydro-Electric Co.? (4) Was the service as good as might reasonably have been obtained with the equipment actually in use? (5) If not, what overcharge was made to the city? (6) Was the city, by the continuance of the company's service with protest, estopped from claiming any refund? Some consider that by this award a few important precedents in similar arbitration were established. The immediate interest of the book to engineers lies in the statements under oath of several men generally recognized as experts in arc-lamp illumination.

There can be little criticism of a true compilation of these records unless such remarks are based on general arrangement and typographical appearance. In these two respects the book is pleasing; the matter is not crowded and the print is clear. The subject matter is arranged largely in the expected sequence of presentation at the hearings of the board of arbitration. First, there is given a brief synopsis of the history of the controversy, of the arbitration arrangement, and of the hearings, testimony and awards. Following this are the exhibits, the testimony, the arguments and the award complete—or very nearly so.

WATER-WORKS DISTRIBUTION.—A Practical Guide to the Laying Out of Systems of Distributing Mains for the Supply of Water to Cities and Towns. By J. A. McPherson, M. Inst. C. E., Chief Engineer, Bristol Water-Works. Second Edition, revised and enlarged. London, England: B. T. Batsford. New York: D. Van Nostrand Co. Cloth; 5¼ × 8 ins.; pp. xiv. + 161; 133 illustrations, mostly in the text, and folding chart. $2.50.

The first edition of this book was reviewed quite favorably in our issue of June 13, 1901, p. 430. No very extensive changes appear to have been made in the present edition, but there has been an attempt to insert references to new devices and methods. It appears from the title page of the present edition that the author is Chief Engineer of the Water-Works of Bristol, England. The water-works practice described is essentially British, with very few references to the many different ways of doing things in the United States. Practically no references are made to any American devices or methods, except to the Venturi meter and possibly some other appliances which have been taken up commercially by British companies. Nevertheless, as we stated in our review of the first edition, the volume contains much that might interest and some things that might instruct the American reader.

LAND TREATMENT OF SEWAGE.—A Digest of the Reports Made to the Royal Commission on Sewage Disposal by Their Specially-appointed Officers. By Herbert T. Scoble, M.R.S.I., F.R.M.S., Professional Associate of the Surveyors' Institution. (Reprinted from "The Surveyor and Municipal and County Engineer.") London, England: St. Bride's Press, Ltd. New York: D. Van Nostrand Co. Cloth; 8½ × 11¼ ins.; pp. 76. $2, net.

The voluminous reports on British sewage farms abstracted in this volume were noted in these columns on page 52 of our issue of Jan. 12, 1905. The original report dealt at length with eight British sewage farms, selected to represent different types of soil, and it also gave statistical information regarding some thirty additional sewage farms. Mr. Scoble has here presented a digest of the voluminous and expensive reports named, which promises to be of interest and value to those to whom the original documents are not accessible, and, we may add, hardly worth the heavy purchase price ($12) for any American not deeply interested in the subject. Mr. Scoble has supplemented his abstracts by quite brief notes on happenings since the material was collected for the reports in question.

RAPPORT D'ENSEMBLE SUR LES MOYENS EMPLOYES JUSQU' ICI POUR COMBATTRE LA POUSSIERE DES ROUTES.—Presented to the Commission appointed by the Minister of Public Works, by M. Le Gavrian, Engineer of Bridges and Parks, Secretary of the Commission. (Extract from "Annales des Ponts et Chausées," Vol. II., 1907.) Paris, France: E. Bernard. Paper; 6¼ × 9½ ins.; pp. 24.

LA LUTTE CONTRE LA POUSSIERE DES ROUTES EN GENERAL ET SPECIALEMENT SUR LE LITTORAL MEDITERRANEEN.—Report presented to the Congrès de Climatothérapie et d'Hygiène Urbaine, held in 1907 at Cannes, Nice, Monaco and Menton. By Dr. Guglielminetti, of Monte Carlo. Paper; 6 × 9½ ins.; pp. 16; illustrated.

The dust nuisance on country roads has led to the organization in France of an "Anti-dust League," the purpose of which society is to study by experiment and teach by practice the various methods of suppressing dust on roads. The two papers noted above are specimens of the literature which the league is circulating. The first is a report presented to a commission appointed to make a study of the dust problem, and treats of the various schemes of oiling, watering and tarring roads both to suppress the dust and to prevent its formation. The second paper was read before a public health society by Dr. Guglielminetti, who has made extensive experiments upon the well-kept roads of Monte Carlo. It is a statement of the results of these experiments.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Proceedings of the 14th Annual Convention, Held at Detroit, Mich., Oct. 1-4, 1907. (A. Prescott Folwell, Secy., Flatiron Building, New York City.) Paper; 5¾ × 8¾ ins.; pp. 264; illustrated. $1.

Nearly half the space devoted to papers and discussions in this report is taken up with street pavements and related subjects, a topic on which the society has always been particularly strong. In addition, there are committee reports and papers on street lighting, sewerage and sewage disposal, parks, uniform building laws, and other topics.

DRAFTING.—A Magazine Devoted to Designing, Detailing, Tracing, Blue-Printing, and Technical Subjects. Vol. I., No. 1, January, 1908. Cleveland, Ohio: The Inland Publishing Co. Paper; 6¾ × 10 ins.; pp. 52; illustrated.

Originally published under the title "The Draftsman," this is the second appearance of this periodical. It is really more ambitious than its title would indicate, the matter pertaining to draftsmen or drafting forming but a minor portion of its contents. The additional matter is, however, intended to be of use to the draftsman in helping him to understand the details of the shop and field, without which his drafting-room knowledge can be but poorly applied.

RECOMMENDATIONS TO THE PRESIDENT.—Regarding the Administration of the Affairs of the District of Columbia. By James Bronson Reynolds. New York: The Author (500 Fifth Ave.). Paper; 5 × 7 ins.; pp. 28.

Briefly stated, recommendations given in this pamphlet are: a governor of the District of Columbia, at a salary of $10,000 per annum;

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City Planning.

THE CITY PLAN.—Edited by Charles Mulford Robinson. Pages 1486 to 1562 of "Charities and The Commons" for Feb. 1, 1908. [Edward T. Devine, Editor, 105 East 22d St., New York.] 25 cts. per copy.

REPORT ON THE IMPROVEMENT OF THE CITY OF DUBUQUE, IOWA.—By Charles Mulford Robinson, A. M. Civic Adviser [Rochester, N. Y.], to Joint Committee Representing Dubuque Commercial Club, Civic Division of Dubuque Woman's Club, and Trades and Labor Congress. Paper; 6 × 9¼ ins.; pp. 32.

REPORT ON THE IMPROVEMENT OF THE CITY OF OGDENSBURG, N. Y.—By Charles Mulford Robinson [Rochester, N. Y.]. Paper; 6 × 8¾ ins.; pp. 12.

Mr. Robinson and the editors and publishers of "Charities and The Commons" have combined to bring together a very useful and suggestive series of papers, by 18 contributors, on utilitarian and esthetic phases of city planning. As a compendium of the most recent ideas and achievements in this line of work, the symposium deserves high commendation. No doubt the edition of the journal containing the symposium will be speedily exhausted, as have similar issues devoted to civic topics.

The two pamphlet reports on Dubuque and Ogdensburg by Mr. Robinson follow the well-known lines of a large number of recent reports on city improvement made by Mr. Robinson and others. The Dubuque report relates chiefly to suggestions for parks, playgrounds and boulevards. The author states that Dubuque seems "to be the city of cities for a comprehensive and beautiful park system," yet up to the present time its park possessions are limited to two little triangles and two little city squares. The topography of Dubuque presents three striking features which lend themselves to city improvement along modern lines: "(1) The river; (2) the bluffs, with their river views; (3) the western highlands with their views of rolling country." Suggestions for utilizing these unusual opportunities are made, and also for providing small ornamental spaces, neighborhood parks, playgrounds and connecting boulevards.

The Ogdensburg report is somewhat unique in that it deals with the improvement of a relatively small community. The author first attacks the approaches to the city, which are by means of the ferry and two railroads, and suggests the reconstruction of the "ferry portal"; improvements to one of the railway stations (such improvements are already being made to the other); placing electric wires under ground; parking the streets; a new bridge, which would at the same time become an attractive park feature and eliminate a railway grade crossing; and improvement of existing parks.

SANITARY OFFICERS OF THE STATE OF NEW YORK.—Proceedings of the Seventh Annual Conference, Held at Convention Hall, Buffalo, Oct. 16-18, 1907. Albany, N. Y.: State Department of Health (Eugene H. Porter, M. D., Commissioner). Paper; 5¾ × 9 ins.; pp. 216.

Among the many papers presented at this conference there may be noted: "Sewage Disposal for Institutions and Small Communities," by Theodore Horton, M. Am. Soc. C. E., Chief Engineer, State Department of Health; "The Laws Relating to the Pollution of Streams," by Alec H. Seymour, Secretary and Deputy Commissioner, State Department of Health; "Sanitary Inspection of Wells and Their Surroundings," by L. M. Wachter, Sanitary Chemist, State Hygienic Laboratory; and an interesting group of papers on sanitary supervision of the milk supply.

OHIO STATE BOARD OF HEALTH.—Annual Report for the Year Ending Dec. 31, 1906. (C. O. Probst, Secretary.) Columbus, O.: Pub. Doc. Cloth; 6¼ × 9¾ ins.; pp. 551; folding and other diagrams.

The greater part of this volume details the work of the board in connection with applications for the approval of sewerage and water-supply plans, the investigation of nuisance complaints, and also investigations of typhoid outbreaks. More than a hundred pages are given to the typhoid outbreak at Youngstown, O., which is considered with special reference to the water filtration plant at that city. An abstract of an advance report on this outbreak by Mr. Paul Hansen, Jun. Am. Soc. C. E., Assistant Engineer of the State Board of Health, was published in Engineering News of Jan. 10, 1907. Numerous analyses of water from public supplies throughout the state are given in the report, and also a considerable volume of vital statistics.

The Cone Test for Hardness.

DIE KEGELPROBE.—A New Method of Testing for Hardness. By Paul Ludwik. Berlin, Germany: Julius Springer. Paper; 5½ × 8½ ins.; pp. 35; one text illustration. One mark; American price, 40 cts.

P. Ludwik has sought to work out a test for hardness which should avoid the defect of the Brinell ball test, namely, the variation in hardness factor with varying size of ball and varying load. He argued that if in a hardness test by pressure the resulting impression be of geometrically similar form in two cases, the ratio of maximum to average stress intensity should be the same, and therefore the hardness factor derived from the test (= Load ÷ area of surface of impression) should be constant for a given material. In the Brinell test this condition is not fulfilled, because the geometrical form varies with depth of impression and radius of ball. By substituting a hardened conical point for the ball, Ludwik obtained more satisfactory results. The cone used is of steel, hardened to glass hardness, ground to shape, with a right angle point. Large depths of impression are better than small depths. The cone point seems to be quite durable. The essential features of the test, and some tables of results, etc., are recorded in the present pamph'et. The results obtained by the cone test bear a close relation to the elastic limit of the material tested, but seem to be independent of its other properties. The test may possibly make for itself a very useful place as a means for determining elastic limit in commercial tests.

THE ASSOCIATION OF MANAGERS OF SEWAGE DISPOSAL WORKS.—List of Members and Associates and Proceedings, 1906. London, England: The Association (Charles B. Ball, Secy., 5 Fetter Lane, Fleet St., E. C.). Paper; 5¼ × 8½ ins.; pp. 112.

The opening pages of this report contain a brief presidential address by Baldwin Latham, M. Inst. C. E., on "The Fluctuation in the Flow of Sewage." Most of the remainder of the report is given up to a description of various British sewage works, chiefly those visited by the association during the year.

It is interesting to note that the association numbers about 140 members, divided approximately as follows: Honorary, 25; members, 105; associates, 10. Under the by-laws of the association, persons eligible as members must "have had the sole management of works under a Sanitary Authority for at least two years, or have been employed as a Sewage Works Manager under an Engineer, Chemist or Surveyor for at least three years;" while associates must "have held the position of Manager, or Assistant Manager, for at least one year." Provision is made for the transfer of associates to full membership as soon as they become qualified.

STEEL CONSTRUCTION.—A Practical Treatise on the Modern Use of Steel in the Erection of Fireproof Buildings, and Its Applications to Structural Work in General. By Edward A. Tucker, M. Am. Soc. C. E., Architectural Engineer. Chicago, Ill.: American School of Correspondence. Cloth; 6½ × 9¾ ins.; pp. 308; 287 illustrations, mostly in the text. $1.50.

The principal requisite of an adequate textbook, next to the presentation of correct information, is an ordered scheme of treatment. The value of such a book does not depend upon the completeness of its contents so much as it does upon a systematic development of the theme which will gradually lead the student by progressive steps out of ignorance to understanding. The usefulness of the text for reference is, of course, very small if the facts are poorly arranged and therefore inaccessible. In this regard this book on "Steel Construction" is at fault. It is designed for home study but the absence of any apparent method in the ar'e discussion reduces considerably the value o. a large quantity of useful material which is found in its pages, notably in that portion devoted to the detailing of connections. Throughout the book the digressions from pure steel construction to contributory studies, the consideration of which are no doubt necessary to a complete treatment, are so inadequately discussed as to make their presence more to be condemned than their absence could possibly have been, had they been omitted. Among these subsidiary references may be mentioned all statements in regard to reinforced concrete—which are about five years behind the times—the short paragraphs on retaining walls and the few pages devoted to roof-trusses. It is not evident just what knowledge the author supposes his students to have when they approach his book, but in the very occasional mathematical discussions he assumes a foreknowledge of mechanics and strength of materials which hardly accords with the elementary nature of the descriptive portion of the book and of the educational status of his readers.

This volume is an excerpt from the "Cyclopedia of Architecture, Carpentry and Building," which we reviewed at some length in our issue of Dec. 12, 1907, p. 660.

OHIO STATE HIGHWAY DEPARTMENT.—Sam Huston, Commissioner. Third Annual Report, Nov. 15, 1906, to Nov. 15, 1907. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 322; two folding maps.

Besides a brief review of the routine work of the department, this report contains the new specifications for macadam roads adopted by the department, instructions to resident engineers and inspectors on highway construction work, the road laws of the state (188 pages), a proposed new state road law, and reprints of the road laws of other states. The road law matter appears to be a reprint of Bulletins 8 and 9, already issued by the department.

Forthcoming Books

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Concrete-Steel Construction
By Prof. E. Mörsch. Translated from the Revised and Enlarged Second German Edition by E. P. Goodrich.

Inspector's Handbook of Reinforced Concrete
By Walter F. Ballinger and Emile G. Perrot.

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Publications Received.

THE ARKANSAS COAL FIELD.—By Arthur J. Collier. Bulletin 326, U. S. Geological Survey. Washington, D. C.: The Survey. Paper; 6 × 9 ins.; pp. 158; diagrams in the text, and half-tones.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.—Proceedings of the 17th Annual Convention, held in Milwaukee, Wis., Oct. 15-17, 1907. (S. F. Patterson, Secy., Boston & Maine R. R., Concord, N. H.) Paper; 6 × 9 ins.; pp. 314; illustrated.

BIRTHS, MARRIAGES AND DEATHS IN THE PROVINCE OF ONTARIO.—Report Relating to the Registration, for the Year Ending Dec. 31, 1905. (Charles A. Hodgetts, M. D., Chief Health Officer of Ontario.) Toronto, Ont.: Pub. Doc. Paper; 6½ × 9¾ ins.; pp. 43 + clxxxiii.

BULLETINS DU LABORATOIRE D'ESSAIS MECANIQUES, PHYSIQUES, CHIMIQUES ET DE MACHINES.—Conservatoire National des Arts et Métiers. Paris, France: Ch. Béranger. Paper; 6½ × 10 ins.

No. 10: Sur la Constitution Intime des Calcaires. By E. Leduc. Pp. 68; four folding plates and 38 folding tables.

No. 11: Essais sur le Plâtre. By E. Leduc and Maurice Pellet. Pp. 25; diagrams and tables.

BUREAU OF STEAM ENGINEERING.—Annual Report of the Chief to the Secretary of the Navy for the Fiscal Year 1907. (C. W. Rae, Engineer-in-Chief, U. S. Navy, Chief of Bureau). Washington, D. C.: Pub. Doc. Paper; 5⅞ × 9 ins.; pp. 56.

CIRCULARS, U. S. FOREST SERVICE.—Gifford Pinchot, Forester. Washington, D. C.: Pub. Doc. Paper, 5¾ × 9 ins.

No. 117: The Preservative Treatment of Fence Posts. By Howard F. Weiss, Forest Assistant. Pp. 15; one text figure.

No. 128: Preservation of Piling against Marine Wood Borers. By C. Stowell Smith, Forest Assistant. Pp. 15; 5 text figures.

No. 134. The Estimation of Moisture in Creosoted Wood. By Arthur L. Dean, Expert. Pp. 7; 3 text figures.

No. 136. The Seasoning and Preservative Treatment of Arborvitæ Poles. By C. Stowell Smith, Forest Assistant. Pp. 29; 7 text figures.

No. 137: (In co-operation with the Department of Commerce and Labor, Bureau of the Census, S. N. D. North, Director.) Consumption of Poles in 1906. Pp. 9.

DEPARTMENT OF RAILWAYS AND CANALS, DOMINION OF CANADA.—Report for 1906-07. Ottawa, Ont.: Geo. P. Graham, Minister of Railways and Canals. Paper; 7 × 10 ins.; pp. lxiv. + 49 + 177 + 89 + 19 + 8.

ECONOMICS OF RAILWAY OPERATION.—By M. L. Byers, Chief Engineer Maintenance of Way, Missouri Pacific Railway. New York: The Engineering News Publishing Co. London, England: Archibald Constable & Co., Ltd. Cloth; 6 × 9½ ins.; pp. 672; diagrams, folding tables and text illustrations. $5, net.

DIE ENTWICKLUNG DER DAMPFMASCHINE.—A History of the Stationary Steam Engine, the Locomobile, the Marine Engine and the Locomotive. Prepared at the Direction of the Verein Deutscher Ingenieure, by Conrad Matschoss. In two volumes. Berlin, Germany: Julius Springer. Cloth; 7½ × 10½ ins. Vol. I.; pp. 834; 780 illustrations in the text and 32 portraits. Vol. II.: pp. 732; 1,073 illustrations in the text and 6 portraits. 24 marks; American price, $9.60.

EXPERIMENTAL ELECTRICAL ENGINEERING.—And Manual for Electrical Testing. For Engineers and for Students in Engineering Laboratories. By V. Karapetoff. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. xxxiv. + 790; 538 illustrations in the text and 1 folding plate. $6.00 net.

GEOLOGIC ATLAS OF THE UNITED STATES.—Winslow Folio. Arkansas-Indian Territory. Washington, D. C.: U. S. Geological Survey; Stiff paper; 18 × 24 ins.; pp. 6; two maps, one plate and figures in the text.

THE GEOLOGICAL MAP OF ILLINOIS.—Second Edition. By Stuart Weller. Bulletin 6. Illinois State Geological Survey. Urbana, Ill.: University of Illinois. Paper; 6 × 9 ins.; pp. 34; large folding map in pocket.

THE GREAT TUNNELS OF THE WORLD.—By Charles W. Comstock. (Proceedings of the Colorado Scientific Society, Vol. VIII.) Denver, Colo.: The Society. Paper; 6¼ × 9½ ins.; pp. 363 to 386.

HILLS WATER SUPPLY.—Report of Board on Schemes to supply the Metropolitan Area (Fremantle to Midland Junction Inclusive) with Hill Water. (W. C. Reynoldson, Chief Engineer Goldfields Water Supply Administration, Chairman.) Perth, Western Australia: Pub. Doc. Paper; 8¼ × 13 ins.; pp. 35; 26 plates.

A HISTORY OF ASTRONOMY.—By Walter W. Bryant, B. A., Superintendent of the Magnetical and Meteorological Department of the Royal Observatory, Greenwich. New York: E. P. Dutton & Co. Cloth; 5½ × 9 ins.; pp. 355; 35 plates. $3, net.

AN INTRODUCTORY COURSE OF CONTINUOUS CURRENT ENGINEERING.—By Alfred Hay, D. Sc., M. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 5½ × 8¾ ins.; pp. 327; 183 illustrations in the text. $2.50, net.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE.—Vol. LXXV., No. III., 1907. Edited by Bennett H. Brough, Secretary. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5½ × 8¾ ins.; pp. 620; text illustrations and 40 plates.

KALENDER FUER DAS GAS-UND WASSERFACH.—By E. Schilling, Civil Engineer. Section on Water by G. Anklam, Manager of the Berlin Water-Works at Friedrichshagen. 31st Year, 1908. Munich and Berlin, Germany: R. Oldenbourg. Leather; 4 × 6½ ins.; pp. 284 + 139; 16 illustrations in the text. 4½ marks; American price, $1.80.

LIBRARY OF CONGRESS.—Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds, for the Fiscal Year Ending June 30, 1907. Herbert Putnam, Librarian. Washington, D. C.: Pub. Doc. Cloth; 5½ × 9½ ins.; pp. 167; eight plates.

THE METALLURGY OF IRON AND STEEL.—By Bradley Stoughton, Ph. B., B. S., Adjunct Professor, School of Mines, Columbia University. New York: Hill Publishing Co. Cloth; 6 × 9½ ins.; pp. 500; 311 illustrations in the text and 33 tables. $3.

MINERAL RESOURCES OF THE UNITED STATES, 1906.—Washington, D. C.: U. S. Geological Survey. Cloth; 6 × 9 ins.; pp. 1,307.

THE NEED OF WATER LEGISLATION IN OREGON.—Special Report No. 1, Office of State Engineer, December, 1907. Prepared at the Request of His Excellency, Geo. E. Chamberlain, Governor, by John H. Lewis, State Engineer. Salem, Ore.: Pub. Doc. Paper; 6 × 9 ins.; pp. 32.

THE NEW YORK PASSENGER TERMINAL OF THE PENNSYLVANIA RAILROAD (Under Construction).—Brief Description of the Main Features of the Engineering Work, Prepared for the Use of Members of the American Society of Civil Engineers, on the Occasion of Their Visit to the Terminal Site at the Annual Meeting in New York, January, 1908. New York: Westinghouse, Church, Kerr & Co. Paper; 6 × 9 ins.; pp. 23; illustrated.

OBSERVATIONS WITH RESPECT TO TYPHOID FEVER IN THE DISTRICT OF COLUMBIA.—By William C. Woodward. Vol. I., No. 13, January, 1908, Medical Science Series, The George Washington University Publications. Washington, D. C.: The University. Paper; 6 × 9 ins.; pp. 107 to 121. 25 cts.

THE POSSIBILITY OF WATERS, IN MAINS UNDER PRESSURE, BECOMING POLLUTED FROM EXTERNAL SOURCES.—By James M. Caird. (A Paper Presented at the 27th Annual Convention of the American Water-Works Association.) Paper; 6 × 9¼ ins.; pp. 493 to 497; one text figure.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.—Sold by the Superintendent of Documents, Washington. Price List 15, 2d Edition. Paper; 4 × 7½ ins.; pp. 54.

RAILROAD COMMISSIONERS (Connecticut).—Annual Report, 1907, to Which Are Added Statistical Tables Compiled from the Annual Reports of the Steam Railroad Companies of the State for the Year Ending June 30, and of the Street Railway Companies for the Same Period. Hartford, Conn.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 439 + 173; two maps in pockets.

RAILWAY STATISTICS OF THE DOMINION OF CANADA.—1906-07. By M. J. Butler, Deputy Minister and Chief Engineer of the Department of Railways and Canals. Ottawa, Ont.: Pub. Doc. Paper; 6 × 10 ins.; pp. 139.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Proceedings of the 15th Annual Meeting, Held in Cleveland, Ohio, July 1, 2, 3, 1907. Vol. XV. Edited by Charles S. Howe, Arthur L. Williston, William T. Magruder. Brooklyn, N. Y.: The Secretary (Pratt Institute). Cloth; 5¾ × 9 ins.; pp. lvii. + 690; illustrated.

STATE RIVERS AND WATER SUPPLY COMMISSION, VICTORIA, AUSTRALIA.—(Stuart Murray, Chairman.) Melbourne, Victoria: Pub. Doc.

Annual Report, 1906-7. Presented to Both Houses of Parliament Pursuant to the Provisions of Section 49 of the Water Act, 1905. Paper; 8 × 13 ins.; pp. 22; one folding map.

Report on the Storage and Distribution of Water in the Wimmera Districts and Southern Mallee Area. Paper; 8 × 13 ins.; pp. 10; one folding map.

Water Act 1905, No. 2016. Paper; 8 × 10¾ ins.; pp. xx. + 136.

STEAM-TURBINES.—By Carl C. Thomas, Professor of Marine Engineering, Sibley College, Cornell University. Third Edition, revised and enlarged. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 334; folding diagrams and numerous text illustrations. $4.

SUBJECT MATTER INDEX OF MINING, MECHANICAL AND METALLURGICAL LITERATURE FOR THE YEAR 1902.—Edited by M. Walton Brown, Secy. Newcastle-upon-Tyne, England: North of England Institute of Mining and Mechanical Engineers. Paper; 6 × 10 ins.; pp. 180. 42 s.; American price, $16.80.

SUPERVISING ARCHITECT OF THE TREASURY DEPARTMENT.—Annual Report for the Fiscal Year Ended June 30, 1907. (James Knox Taylor, Supervising Architect.) Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 303.

THOMAS ALVA EDISON.—Sixty Years of an Inventor's Life. By Francis Arthur Jones. New York: Thomas Y. Crowell & Co. Cloth; 5¼ × 8½ ins.; pp. 362; 29 plates. $2, net.

TRANSVAAL MINING DEPARTMENT.—Annual Report of the Government Mining Engineer for 1906-07. By H. Weldon. Pretoria, Transvaal: Pub. Doc. Paper; 9 × 13 ins.; pp. 68 + tables; maps, diagrams and half-tones.

TRAVELING ENGINEERS' ASSOCIATION.—Proceedings Chicago Meeting, 1907. Buffalo, N. Y.: W. O. Thompson, Secy. Leather; 6 × 9 ins.; pp. 340; folding plates.

WATER AND SEWAGE PURIFICATION PLANTS IN OHIO.—Partial Report of an Investigation Made under Authority of an Act of Legislature, Passed Feb. 23, 1906. (R. Winthrop Pratt, Chief Engineer State Board of Health.) Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 41.

WHITTAKER'S ARITHMETIC OF ELECTRICAL ENGINEERING.—For Technical Students and Engineers. Containing 72 Worked Examples and 300 Exercises. London, England: Whittaker & Co. (New York: The Macmillan Co.) Cloth; 5 × 7½ ins.; pp. 159; 13 figures in the text. 50 cts.

THE YUKON TERRITORY.—Reports Issued by The Hon. Frank Oliver, Minister of the Interior, Ottawa, Ont. Paper; 6½ × 10 ins.; illustrated by half-tones.

History and Resources. Pp. 140; with map.

General Report. Pp. 20.

WATER POWER VALUATIONS.—Computation of the Values of Water Powers, and the Damages Caused by the Diversion of Water Used for Power; by Charles T. Main.—Damages Caused by the Diversion of Water Power; by Clemens Herschel.—Water Rights; by Richard A. Hale. (Reprinted from Journal of the New England Water-Works Association, Vol. XXI., No. 3.) Paper; 6 × 9¼ ins.; pp. 214 to 278; illustrated.

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